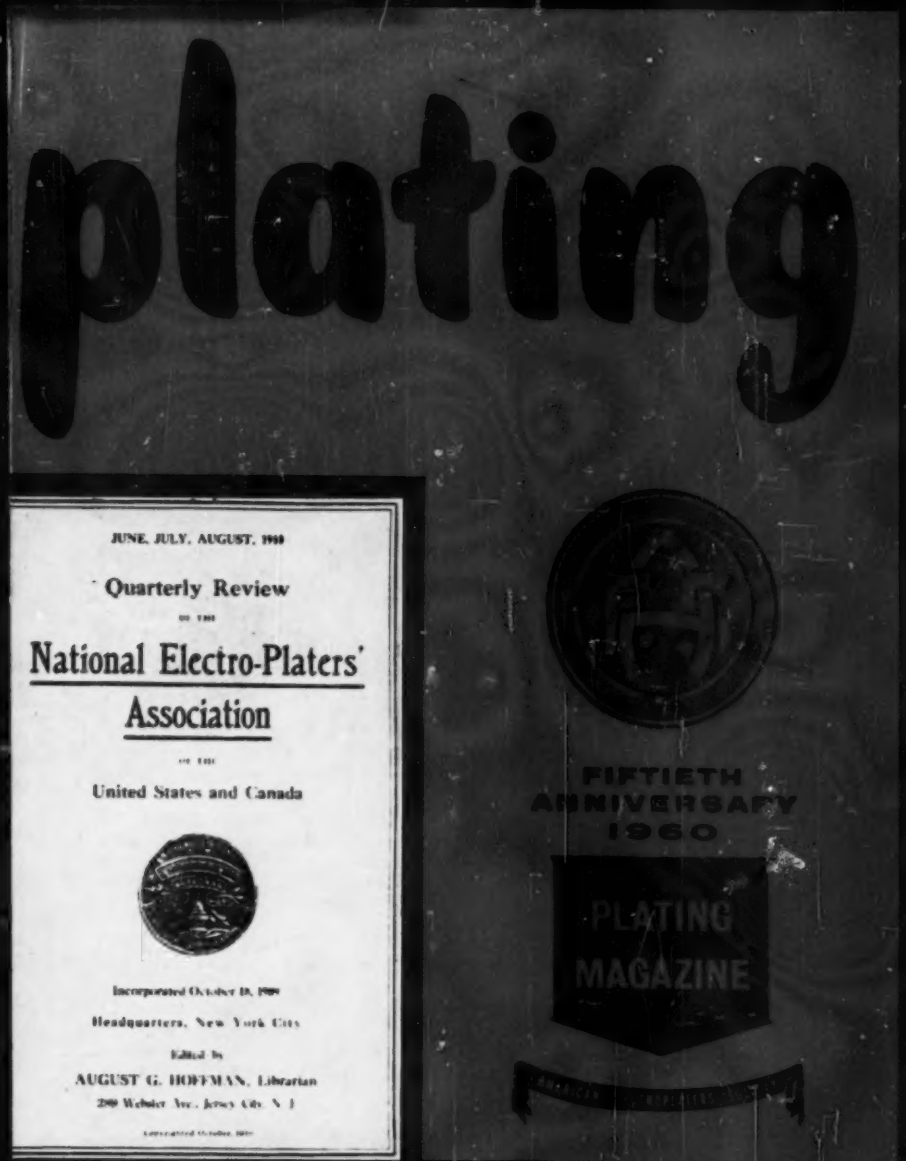

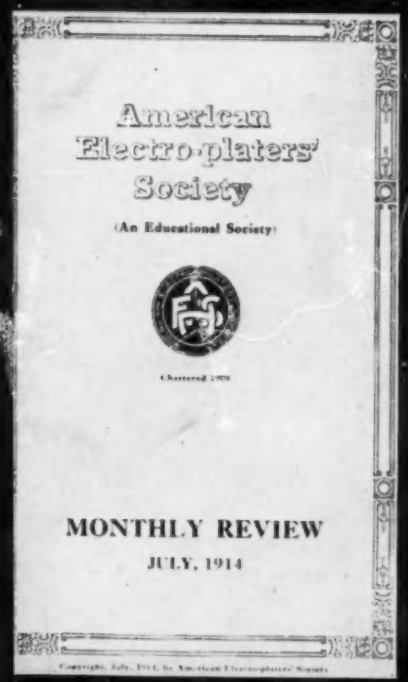

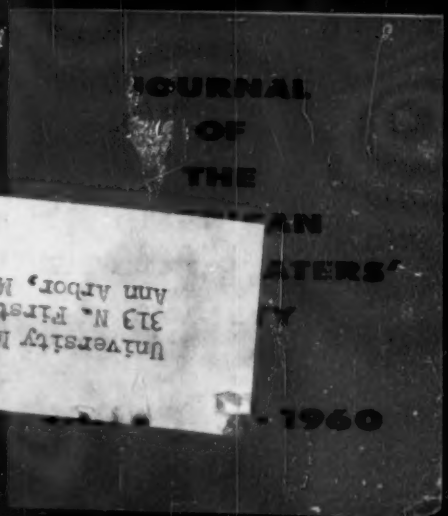

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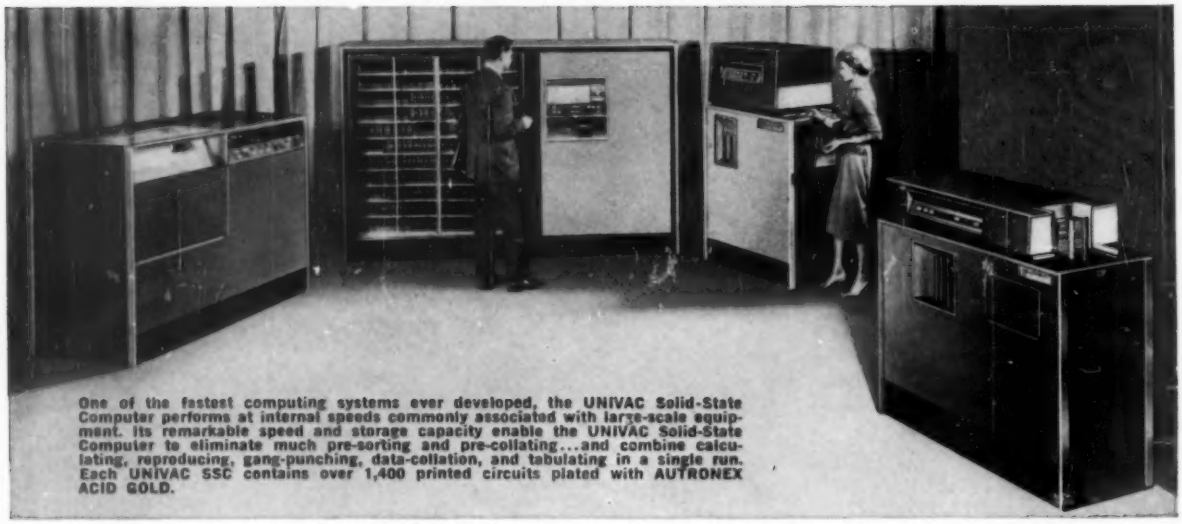

One of the fastest computing systems ever developed, the UNIVAC Solid-State Computer performs at internal speeds commonly associated with large-scale equipment. Its remarkable speed and storage capacity enable the UNIVAC Solid-State Computer to eliminate much pre-sorting and pre-collating...and combine calculating, reproducing, gang-punching, data-collation, and tabulating in a single run. Each UNIVAC SSC contains over 1,400 printed circuits plated with AUTRONEX ACID GOLD.

REMINGTON RAND USES AUTRONEX* ACID GOLD PROCESS TO PLATE UNIVAC PRINTED CIRCUITS

Remington Rand, Division of Sperry Rand Corporation, Utica, New York, uses the AUTRONEX ACID GOLD PROCESS to plate printed circuit boards for their world-famous UNIVAC Solid-State Computer Systems and Equipment. Installation of the patented AUTRONEX ACID GOLD PLATING PROCESS for this work, "...totally eliminated resist failures and rejects in the electroplating phase," according to a report from Remington Rand's Supervisor of Chemical Engineering.

This report goes on to say that "AUTRONEX ACID GOLD in printed circuit production offers definite advantages and promotes the highest quality production." Here are some of these advantages proved in Remington Rand's own laboratories:

1. Harder and more wear-resistant surfaces.
2. Elimination of one step in plating cycle — no cyanide gold strike required.
3. Promotes higher bond strength of circuit to dielectric base material by minimizing danger of damaging the adhesive layer.
4. Solder flow through plated holes is definitely better, thereby improving over-all quality.
5. AUTRONEX ACID GOLD has totally eliminated circuit lifting and rejects on boards plated after etching. Formulations used previously attacked the adhesive and undermined the circuit paths.

The conclusion of the report we have been quoting needs no further comment: "We would like to commend the manner in which your company has serviced us in regards to materials, equipment and valuable advice. In many instances your promptness in making equipment and materials delivery has been instrumental in meeting vital production target dates."

The patented AUTRONEX ACID GOLD PLATING PROCESS has production-proved its unique advantages for over two years in the plants of leading manufacturers the world over. AUTRONEX can help *you* make a better, more reliable product—probably at far less cost than with any gold plating formulation you may be presently using. Evaluate AUTRONEX ACID GOLD ELECTROPLATE in your own plant, *on your own product*. We'd be happy to plate sample parts for you at no obligation. Write...wire...or 'phone. We'll make all the arrangements.

*Trademark for Sel-Rex patented Acid Gold Plating Process

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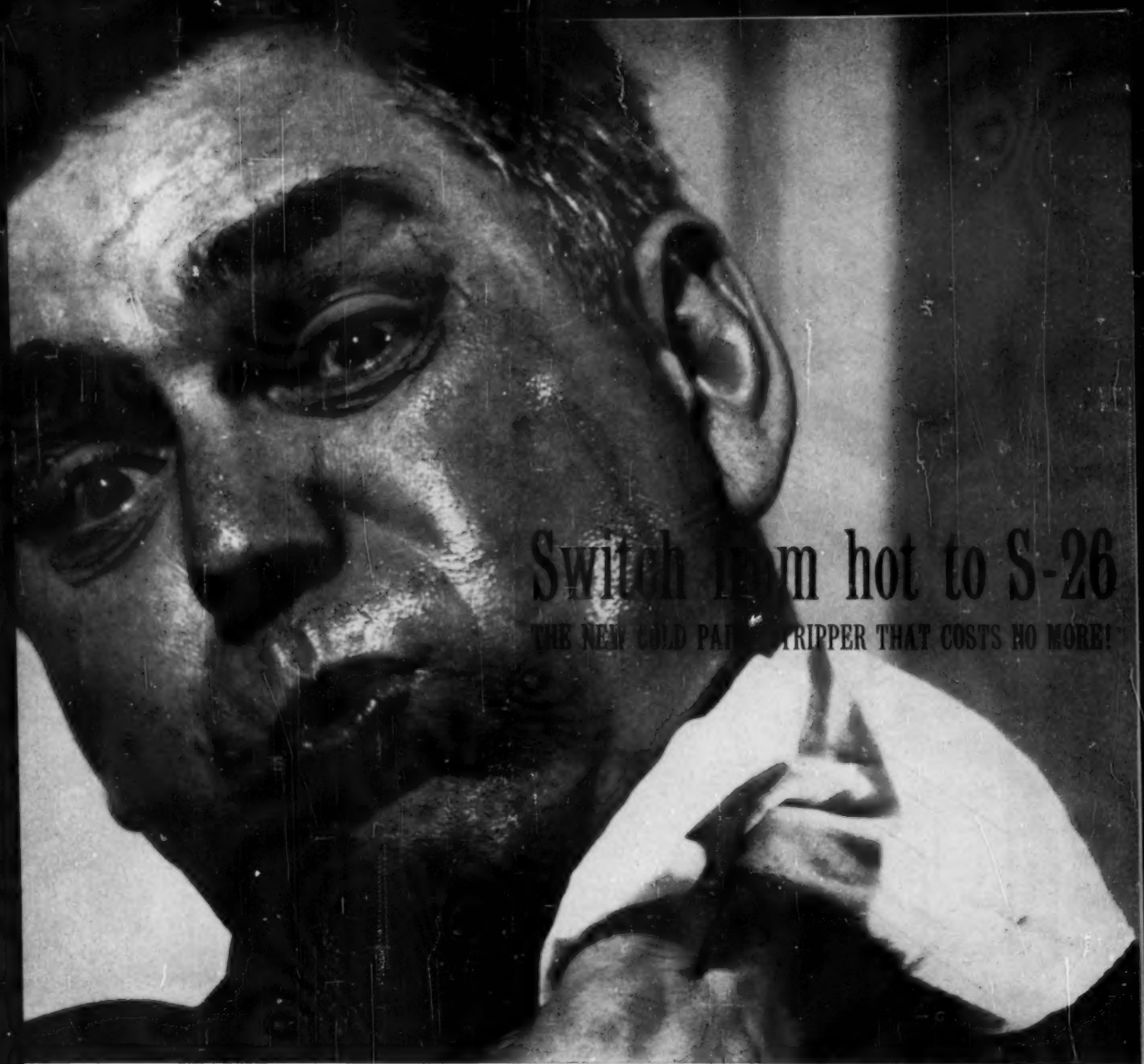
The world's fastest and most advanced electronic data processing system for business and scientific use, the UNIVAC Larc Solid-State computer, by the Remington Rand Division, Sperry Rand Corporation. The new system, which operates up to 200 times faster than any computer in existence, can perform 250,000 additions and subtractions of 12-digit decimal numbers per second.

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 100.



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Get all the facts right now about economical, cold paint stripping by calling your Enthone representative for a demonstration of Stripper S-26. Or write to Enthone, Inc., 442 Elm Street, New Haven, Connecticut, for complete literature.

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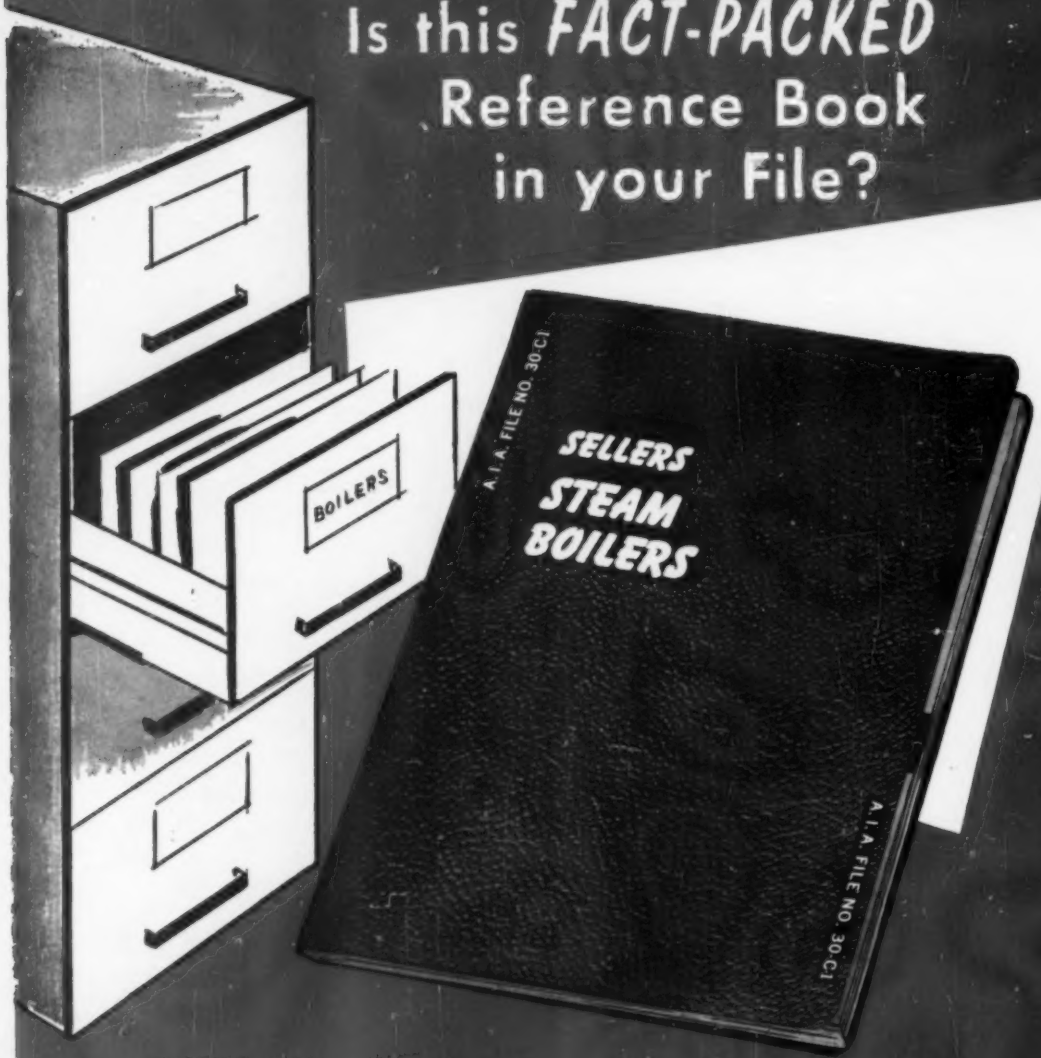

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JOURNAL OF THE AMERICAN ELECTROPLATERS' SOCIETY
FIFTIETH ANNIVERSARY ISSUE

JANUARY 1960 — **Vol. 47, No. 1**

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EDITORIAL

PLATING MAGAZINE: HALF-CENTURY AFTER BIRTH

FOR A FULL twelve-month period, July 1, 1958 through June 30, 1959, the American Electroplaters' Society, Inc. (AES) broadly observed its GOLDEN JUBILEE that reached its climax with AES's GOLDEN JUBILEE Convention and Industrial Finishing Exposition, including the Fifth International Conference on Electrodeposition and Metal Finishing, held in Detroit, Michigan, June 15–19, 1959.

AES programmed and conducted that year-long project principally because it afforded the Society not only occasion for thanksgiving for the rewards of a half-century's progress, but also opportunity to analyze the Society's developments through those fifty years and apply the teachings of AES's yesterday to help meet the challenges of its today and tomorrow. Our industry, our Society, our members, our educational mission, all benefited in many effective public relations ways from the educational, informational and institutional impact of the GOLDEN JUBILEE.

With the dawn of 1960, AES has reached another milestone in its surging history, namely the FIFTIETH ANNIVERSARY of its own official journal—its PLATING MAGAZINE.

Born as "Quarterly Review" in 1910—fashioned into "Monthly Review" in 1914—transformed into today's PLATING MAGAZINE in 1948—PLATING, for a half-century, has concentratedly served the electroplating, metal finishing and allied arts industry.

From humblest beginnings, PLATING has burgeoned through the years to its status today as one of the foremost monthly magazines of its kind, rated high internationally and enjoying the largest audited paid circulation in its field. It is a member of the Audit Bureau of Circulations (ABC) and of the Society of Business Magazine Editors (SBME). It is indexed in Applied Science and Technology Index and is abstracted regularly in Chemical Abstracts, Metals Review, Metallurgical Abstracts, Engineering Abstracts, Engineering Index, Technical Data Index and Bulletin Analytique.

Including technical or scientific papers first favorably considered by panels of anonymous reviewers expert on the respective subjects, its balanced monthly contents are targeted to PLATING MAGAZINE's own specific readership.

This January 1960 Issue is intended to mark the FIFTIETH ANNIVERSARY of PLATING MAGAZINE. As companion edition of its AES GOLDEN JUBILEE ISSUE of June 1959, may it too merit your very large interest.

Ralph D. Wysong
President
American Electroplaters' Society

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3. Lowest advertising rates for reaching the foregoing market.
4. Reader's Service Card assistance to advertisers in seeking readers' response to their advertising.
5. Mailing service available at nominal cost to its regular advertisers thereby enabling them to link direct mail promotion with their magazine advertising.

PLATING MAGAZINE is a member of Audit Bureau of Circulations (ABC). Its circulation is audited by experienced ABC circulation auditors. The facts thus obtained are issued in ABC reports which show how much circulation PLATING has—how it was obtained—where it was distributed—and other information that tells businessmen what they get for their advertising investment in PLATING MAGAZINE'S advertising columns.

Ask to see a copy of our latest available ABC report. Ask, too, for our free booklet, "Market Data and Media File."

Through the reports issued by the Audit Bureau of Circulations, this magazine, along with other publisher members of ABC, voluntarily and regularly give the buyers of advertising more verified factual information than is available for any other advertising media at any time.

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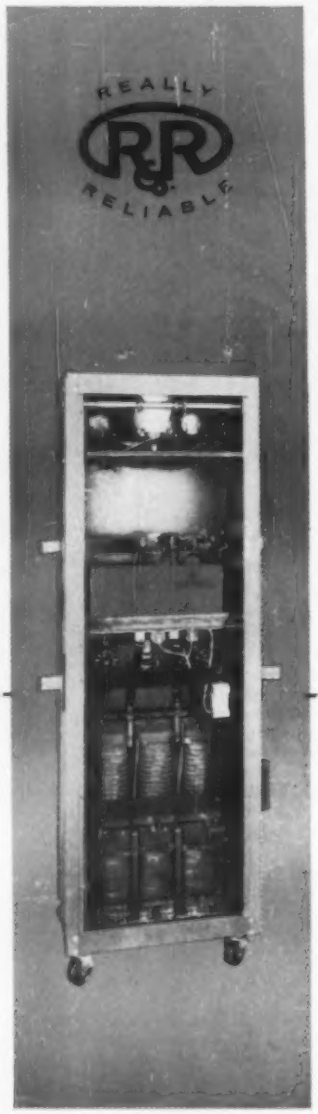

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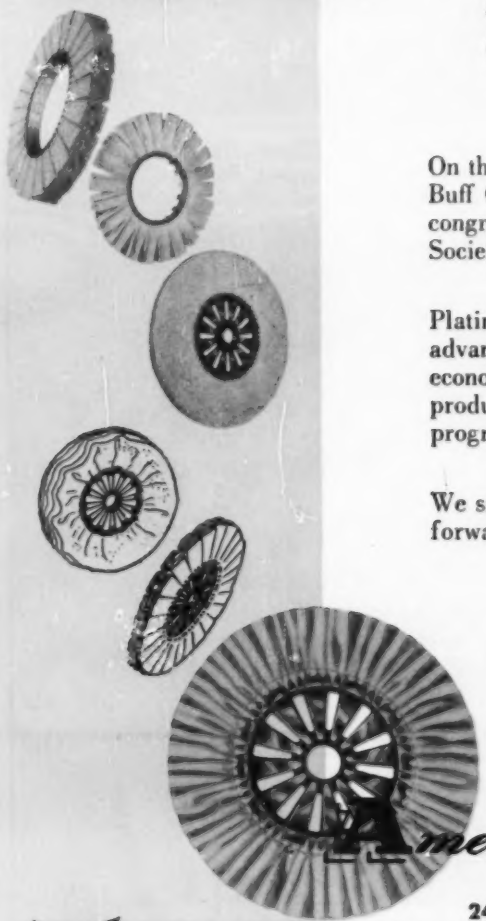
A timely message on

The Outstanding Achievement of Plating Magazine

by Ben P. Sax

Chairman of the Board, *American Buff Company*



On this, the Golden Anniversary in Plating's career, American Buff Company is proud to be among the many friends to congratulate the Journal of the American Electroplaters' Society on its successful influence in the field.

Plating's contribution to the widespread knowledge of technical advances, new finishing techniques, business trends and economical operating methods for all phases of management, production and design have in great part contributed to the progress of the entire metal finishing industry.

We salute Plating, on this half-century of achievement, and look forward to many more years of beneficial association.

Sincerely,

Ben P. Sax

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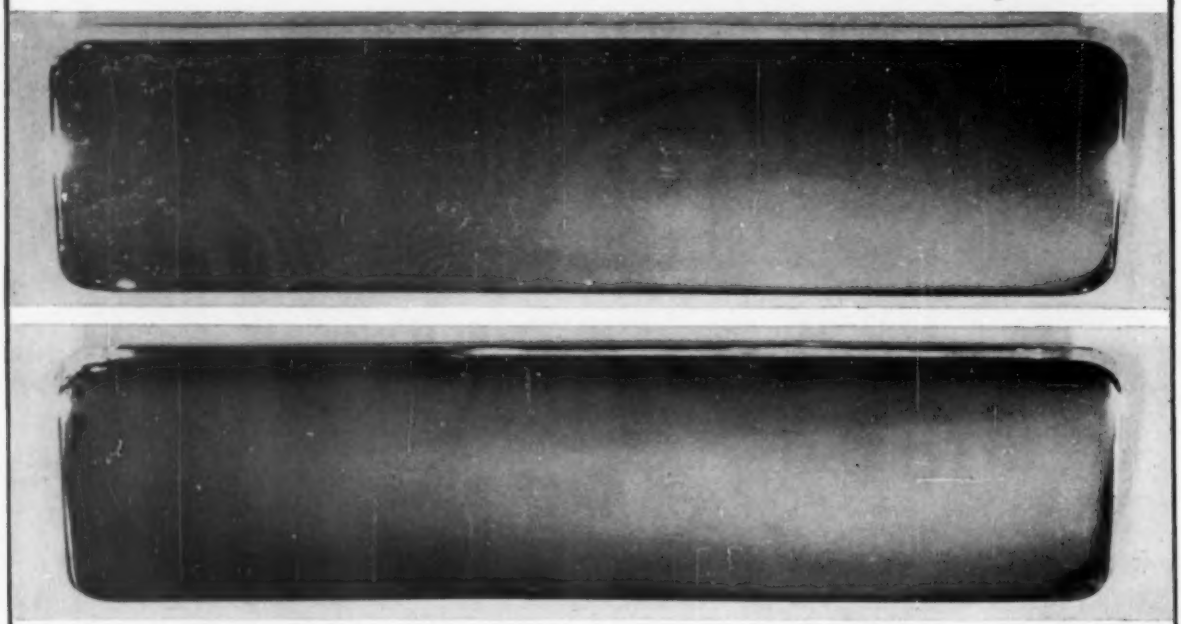

These unretouched photos show plated zinc die-cast bars. *Top Photo:* Plating defects are visible on a bar precleaned with a conventional soak cleaner. *Bottom Photo:* Note the bright, lustrous, defect-free plate of the bar precleaned with Kelite SUPERSOLV as the soak cleaner.

For *bright, defect-free* die-cast plate . . .

Use Kelite SUPERSOLV as the Soak Cleaner prior to electrocleaning.

• What SUPERSOLV* is . . .

SUPERSOLV is a non-etch, non-passivating alkaline soak cleaner for zinc-base die-cast parts.

• What SUPERSOLV* does . . .

Used at a concentration of 5 oz./gal. at 160° to 170° F., SUPERSOLV removes mineral oils, buffing compositions and shop soils in a 1 to 2-minute soak cycle without sensitizing or staining the parts, or making them subject to roughness after electrocleaning and acid dip. The result is defect-free plate of improved brightness and lustre.

WRITE FOR PROCESS DETAILS ABOUT A TYPICAL ZINC-BASE DIE-CAST CLEANING CYCLE USING SUPERSOLV

*Patented, U. S. Patent Office

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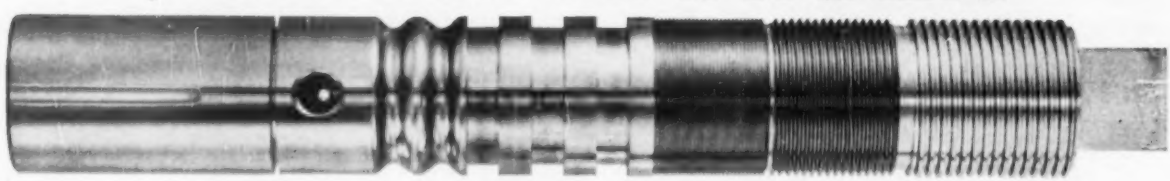
THEY LAUGHED WHEN WE SAT DOWN TO PLATE...

they didn't know about KANIGEN®



This shaft was turned. It was key-slotted, drilled, tapped and shouldered. It was threaded, milled, grooved and chamfered. It was step-bored, with three inside diameters. Who could plate a piece like this all over—inside and out—and expect a uniform coating?

Well, anyone who used KANIGEN® could expect it—and get it. In fact, we made this piece especially to prove it.

The KANIGEN® process for chemical nickel alloy plating produces a uniform thickness of coating, regardless of the contours of a part. This uniformity permits full machining operations prior to coating, with no subsequent cleanup.

KANIGEN® offers corrosion resistance equal or superior to that provided by wrought or electrolytic nickel.

For complete technical details write or call your nearest General American office. Ask for Kanigen Bulletin No. 258. You'll find that with plating as in so many other industrial areas, *it pays to plan with General American.*

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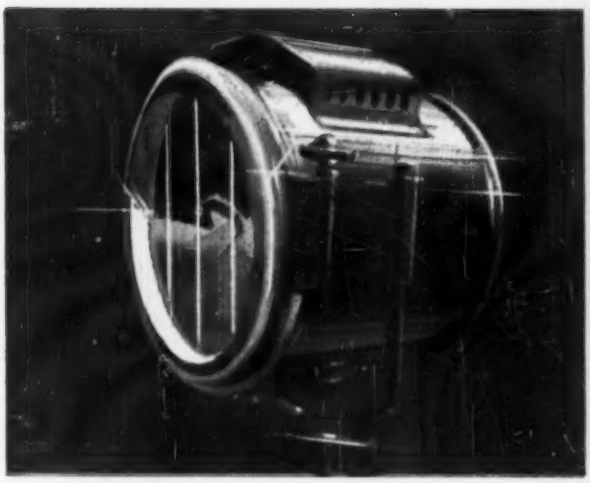
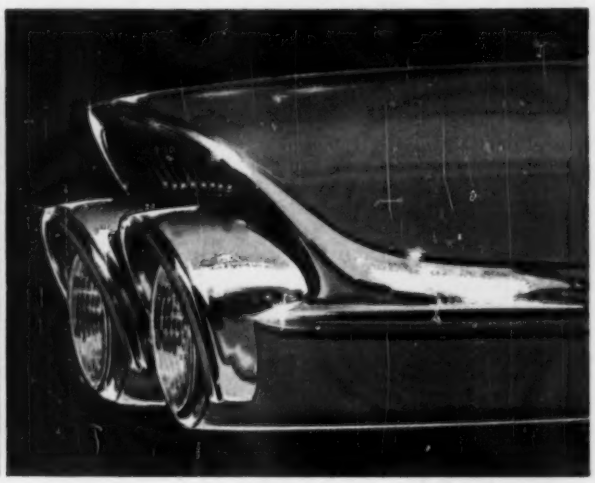


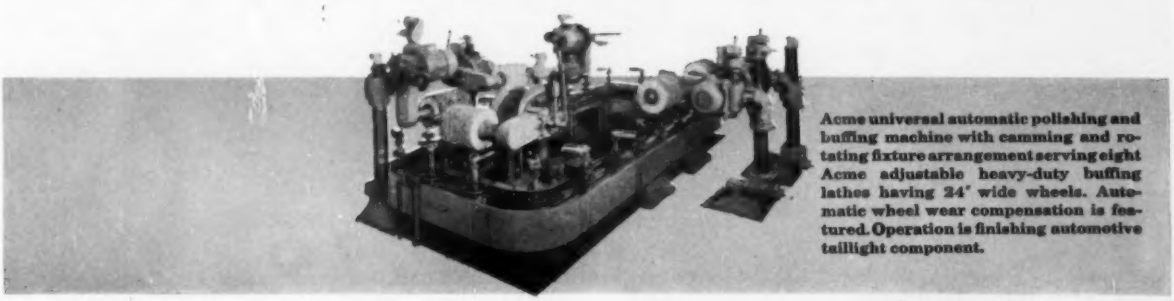


Even in 1910, part of an owner's pride in his car lay in gleaming brightwork. But polishing and buffing the shiny metal that he loved so well caused manufacturers plenty of headaches. And so they turned to Acme—and Acme has continued to supply the answers to their finishing problems.

Today, Acme engineers combine standard units with a variety of accessories to make custom polishing and buffing machines. Large corporations and small job shops alike use Acme machines to reduce rejects, increase production volume, machine finish odd-shaped pieces.

Every year of its history, Acme has encountered new finishing requirements—each an individual problem—and solved them. Chances are, we can solve your problem, too. Send for illustrated 16-page catalog today.

50 years of *Polishing Off* your finishing problems



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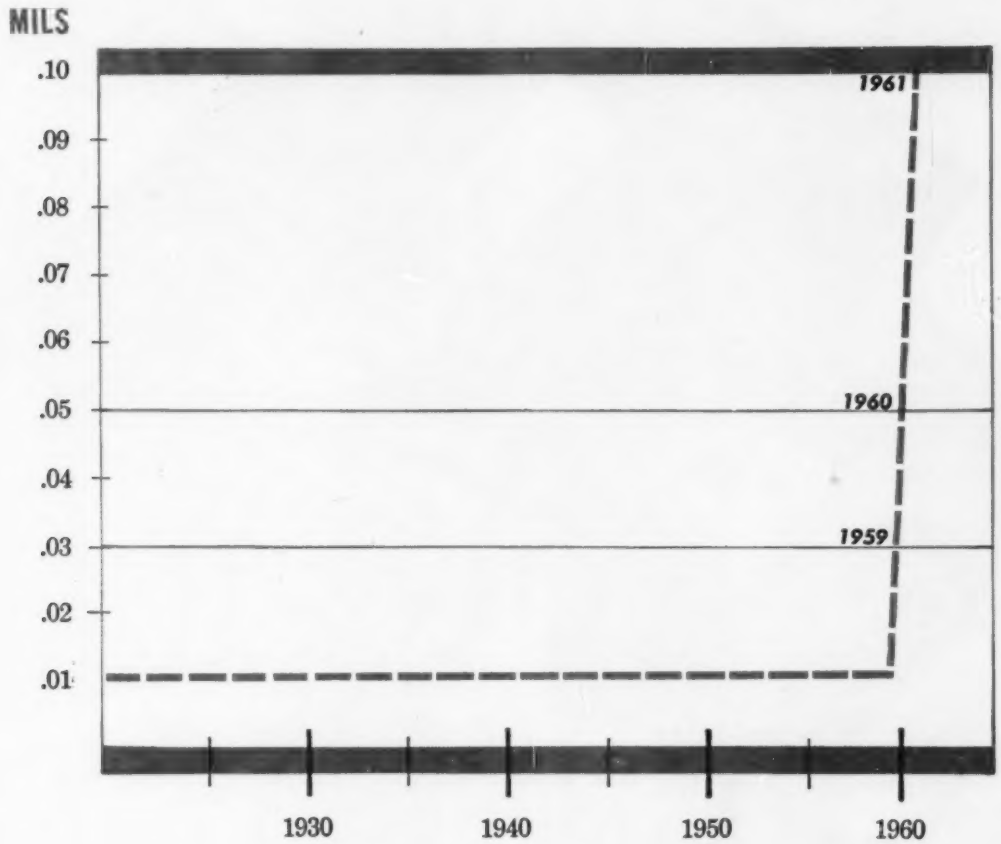

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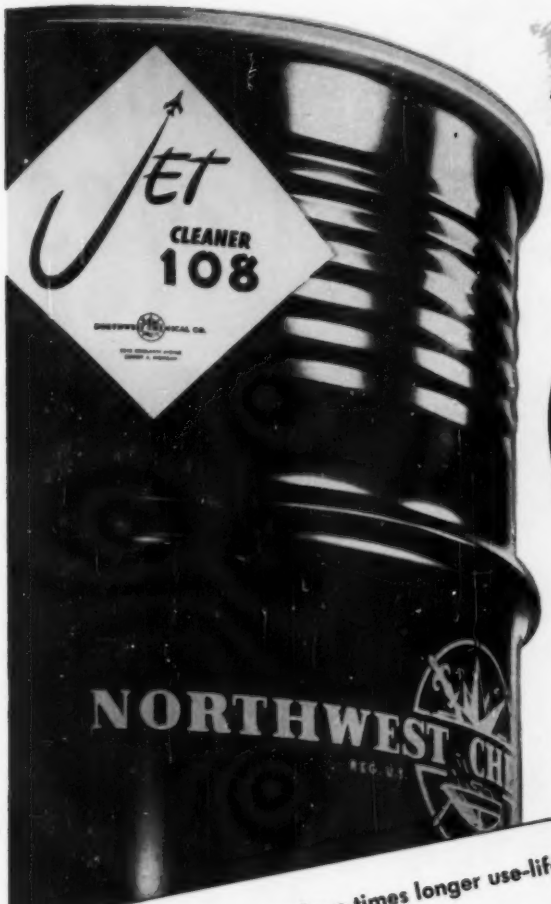

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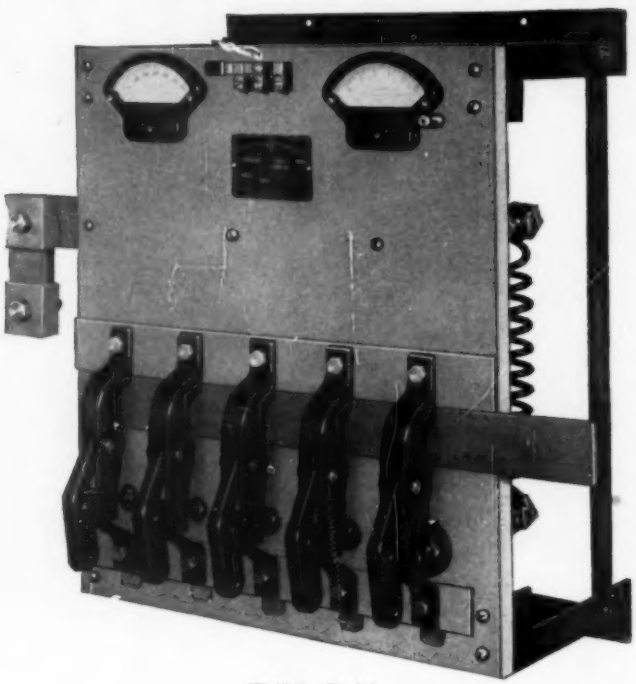

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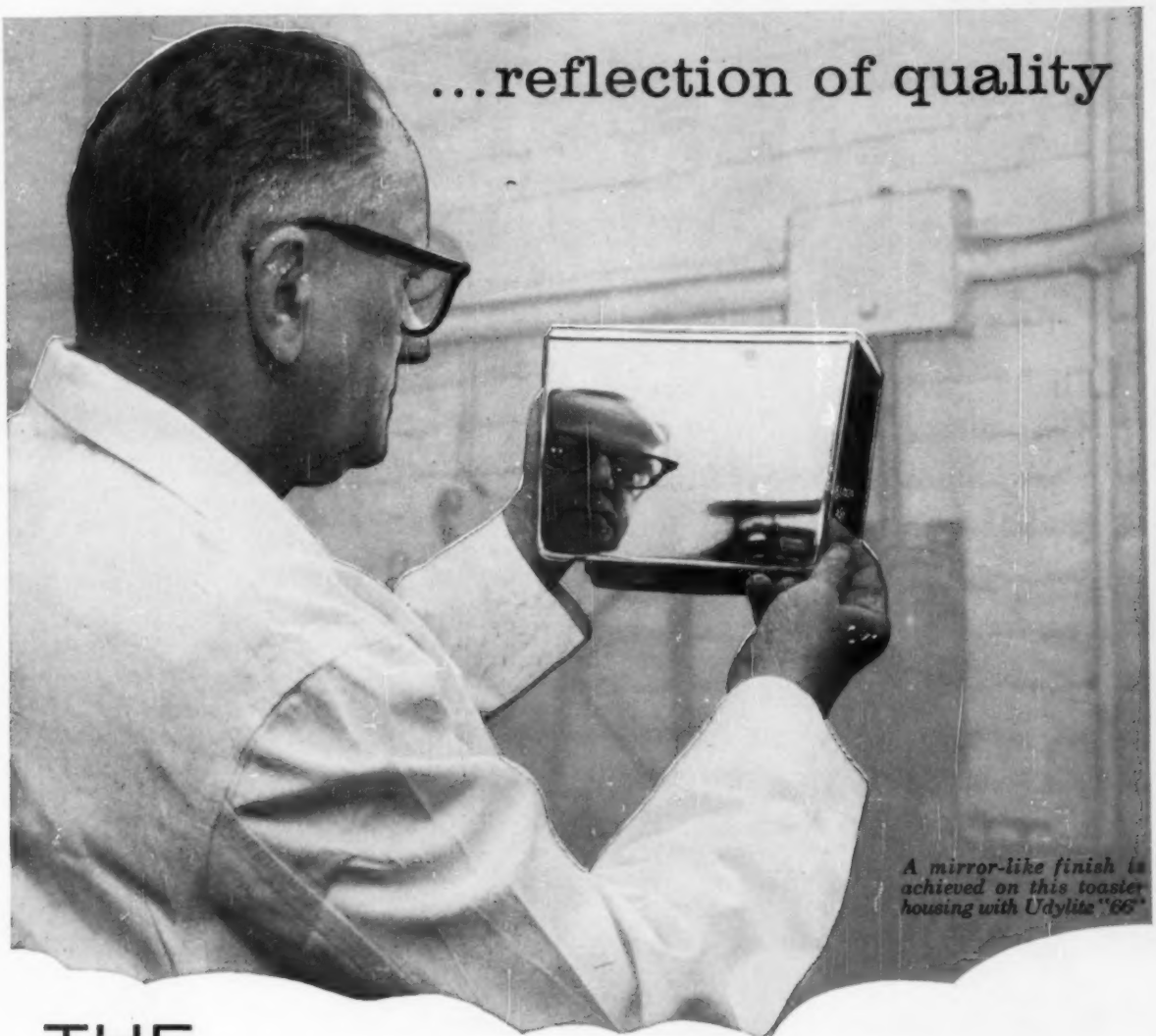

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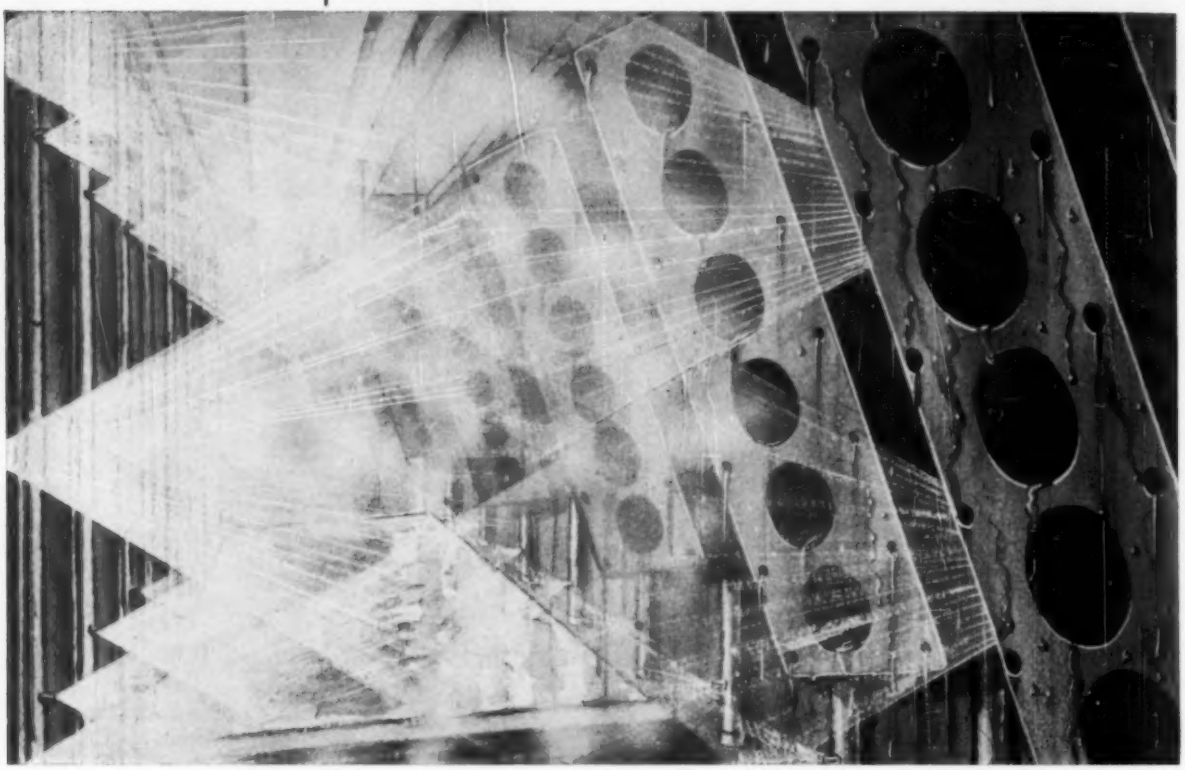

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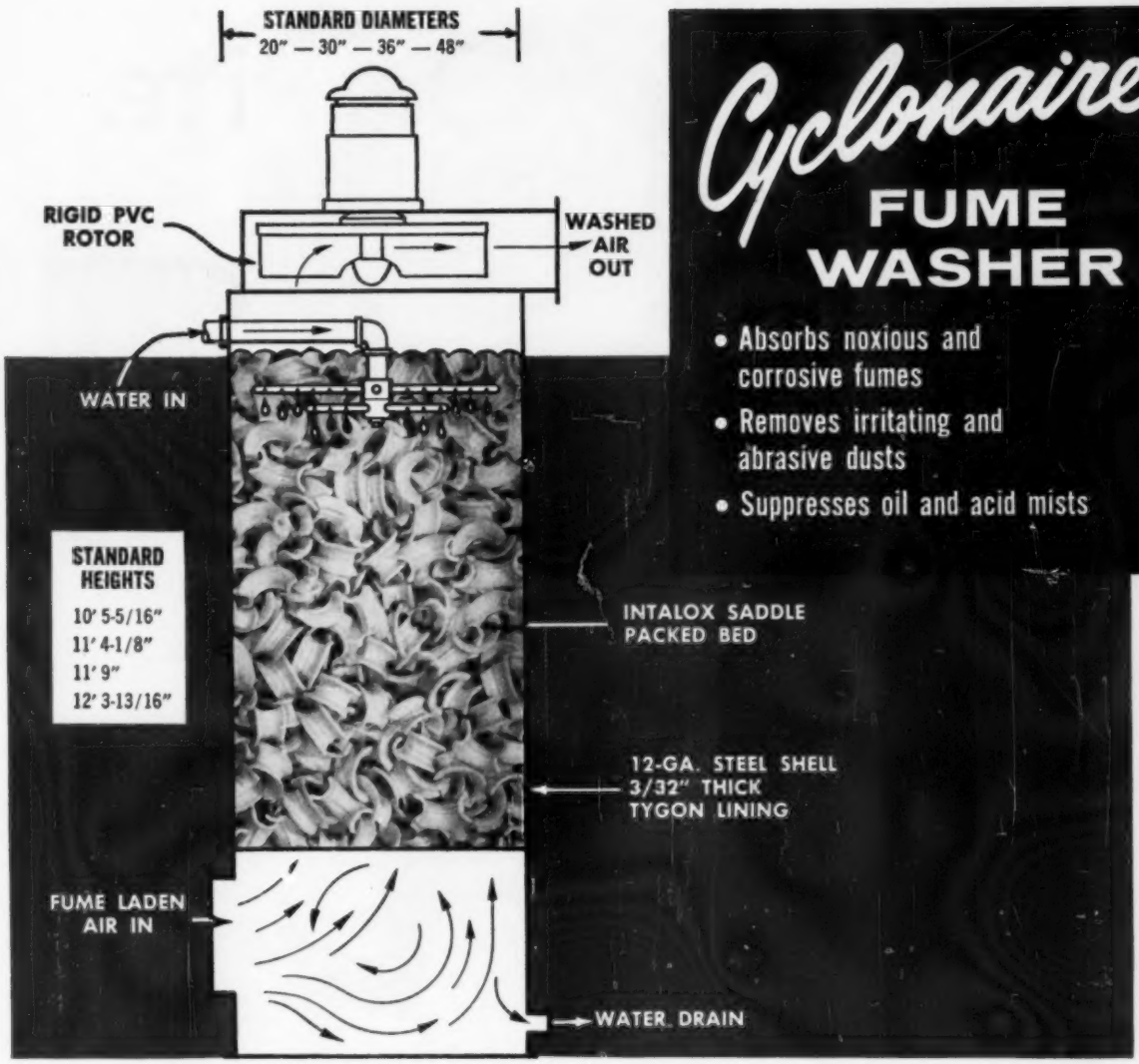

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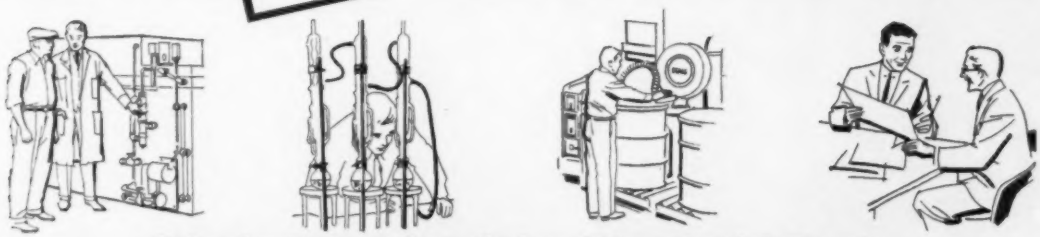

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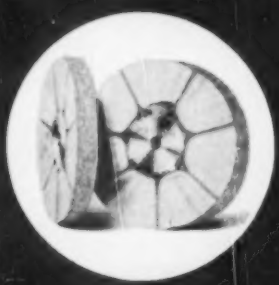

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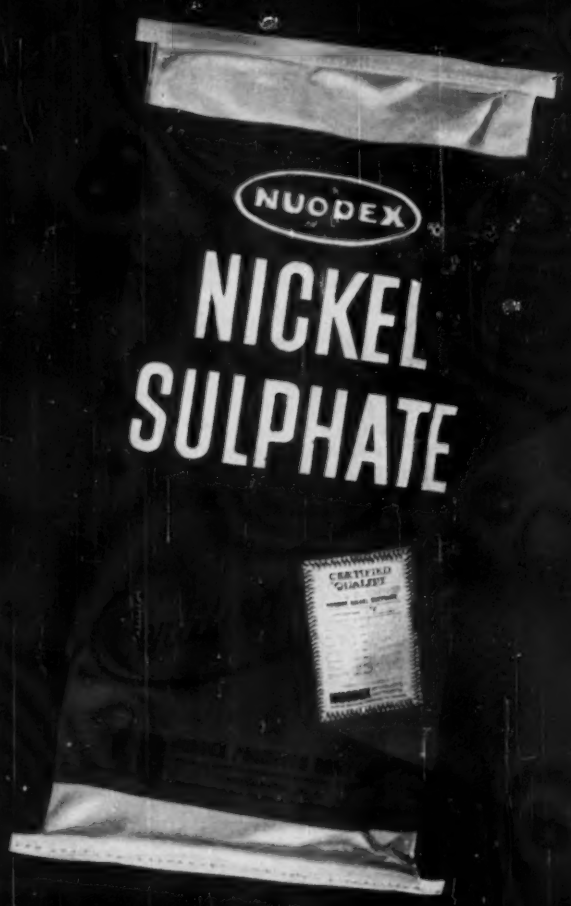

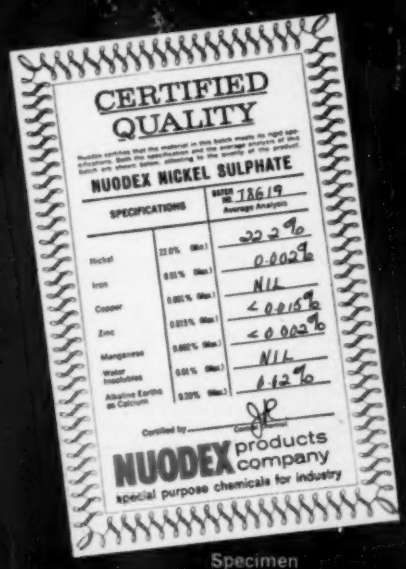

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AWAITED internationally, the book TECHNICAL PROCEEDINGS (Golden Jubilee Edition) has just been completed, and copies have now been mailed to all corners of the world to accommodate members of the American Electroplaters' Society (AES), its exclusive publisher. A limited number of copies are available for sale to AES non-members.

The unique book contains the full text of each of the 43 technical papers on electroplating, metal finishing, organic coating and allied arts by experts of nine countries, including the United States, England, Canada, Australia, France, Germany, Holland, India and Italy, delivered before the Fifth International Conference on Electrodeposition and Metal Finishing, educational sessions element of the AES's Golden Jubilee Convention held in Detroit, Michigan, June 15–19, 1959.

Embodying, too, the charts, diagrams graphs, tables and other illustrations of each of the 43 published papers, *the book also includes the transcript of the discussion that attended the delivery of each paper.* A full list of the papers published in this voluminous treasure chest of knowledge appears on the facing page of this announcement.

Spanning some 400 pages (by far the largest annual TECHNICAL PROCEEDINGS ever published by the AES in its half-century lifetime), this 1959 edition also includes, among other data, a day-to-day log of the Golden Jubilee Convention; a section on the AES Scientific Achievement Award and on other AES technical and scientific awards and honors bestowed at the Golden Jubilee Convention; a full listing of the Boards and Standing and Special Committees that served the AES during its Fiftieth Anniversary year, and a complete AES Branch Directory.

HOW TO ORDER YOUR COPY

A LIMITED extra quantity of the book has been printed to meet the sizable interest shown in it by AES non-members internationally. Orders for copies of the book are now invited from AES non-members, and will be accepted on strictly a "first come-first served" basis so long as that extra supply lasts. The book is unavailable elsewhere.

Within the continental limits of the United States, the domestic price of this Golden Jubilee Edition of AES's TECHNICAL PROCEEDINGS (1959) is $20 per copy including postage.

To those ordering from outside the United States' continental limits, the charge is $25 per copy including postage.

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INTERNATIONAL CONFERENCE: ITS AES HALF-CENTURY SETTING

DRAMATIC and fitting climax of its year-long FIFTIETH ANNIVERSARY observance, American Electroplaters' Society, Inc. (AES) conducted its unique Golden Jubilee Convention and Industrial Finishing Exposition, including the concurrent Fifth International Conference on Electrodeposition and Metal Finishing, in Detroit, Michigan, June 15-19, 1959.

GREETED by the President of the United States, the AES was welcomed to Michigan and Detroit by Governor G. Mennen Williams. The entire week of the AES's Convention, Exposition and International Conference was proclaimed by Detroit's Mayor as "AES GOLDEN JUBILEE WEEK IN DETROIT."

AS the Fifth International Conference on Electrodeposition and Metal Finishing, the Golden Jubilee Convention's educational sessions numbered eleven. Experts from nine countries, including the United States, England, Canada, Australia, France, Germany, Holland, India and Italy, presented 43 technical and scientific papers enriching knowledge in electroplating, metal finishing and allied arts. High spot of the sessions was the first "William Blum Lecture" that was delivered by the eminent Dr. William Blum, first winner of the AES Scientific Achievement Award, the Society's highest honor.

UNDER the supervision of the AES's Editorial Board, in collaboration with the International Council on Electrodeposition and Metal Finishing, the International Conference was planned for the AES by AES Past President Walter L. Pinner, Chairman of the International Council. His Committee included Dr. T. P. Hoar, Dr. Simon Wernick, A. W. Wallbank, R. A. F. Hammond and George Gardam of England and Myron B. Diggin, Dr. Walter R. Meyer and Dr. Richard B. Saltonstall of the United States.

OPENING SESSION OF THE FIFTH INTERNATIONAL CONFERENCE ON ELECTRODEPOSITION AND METAL FINISHING

(1) Chairman Walter L. Pinner extending official welcome. Dr. William Blum, AES Scientific Award winner, seated. (2) Crowded auditorium at the first session. (3) Session Chairman T. P. Hoar introducing Dr. Blum, who delivered the first William Blum Lecture.

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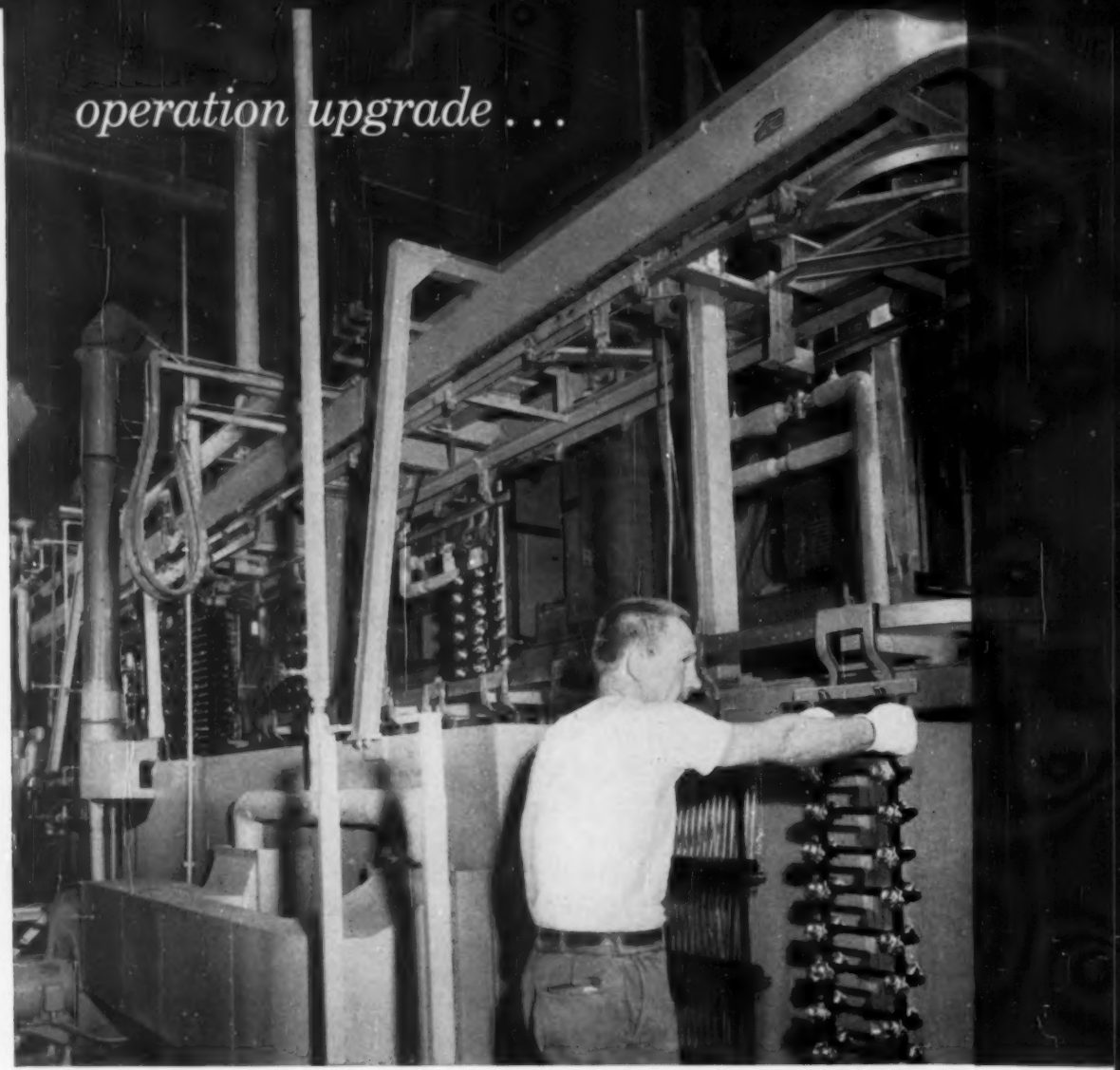

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Dr. Anton Geuther, 1833–1889
From Berichte **63** (Abteilung A), page 145, 1930

THE DEVELOPMENT OF CHROMIUM PLATING

by **GEORGE DUBPERNELL***

INTRODUCTION

WHILE CHROMIUM WAS FIRST deposited from chromic acid solution by Geuther in 1856, over 100 years ago, it was not until 68 years later, in 1924, that the present process of chromium plating was developed by Fink and Eldridge in America, and simultaneously by Liebreich in Germany. Many efforts were made during this 68 year period, but they were all essentially unfruitful. The major attention was devoted to chromium plating from the more logical trivalent and bivalent solutions, starting with the publications of Becquerel, Junot and Bunsen in 1843 to 1854.[1, 2]

GEUTHER'S DISCOVERY

Anton Geuther was born April 23, 1833, and was awarded the PhD degree at Goettingen, Germany in 1855, when he was 22 years old.[3] Here he served as Friedrich Woehler's assistant until 1863, when he went to Jena as professor of chemistry for the rest of his life, until 1889. Up until this time it was considered that an element had only a single characteristic valence, and Geuther devoted the major part of his career to demonstrating the multiple valences of different elements.

One of his first efforts in this direction was some "Electrolytic Experiments,"[4] in which he studied the electrolysis of chromic acid solutions, in addition to ferric chloride and molten potassium dichromate. Geuther made his own chromic acid from potassium dichromate with sulfuric acid, and must have achieved greater purity than many later workers, since he obtained chromium deposits. He started out to check one of Faraday's laws, and reported obtaining about a one-third excess of oxygen at platinum anodes when electrolyzing chromic acid solutions.

This supposed discovery placed him in conflict with an older and more experienced professor, Dr. Heinrich Buff of

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Giessen.[5] Buff's work was said to rival that of Faraday, and Buff had been conducting electrochemical investigations for about 15 years before this time. In order to check Geuther's result Buff electrolyzed[6] solutions of neutral potassium chromate, "chemically pure" chromic acid made for him by A. Moldenhauer, chromic acid with sulfuric acid added, potassium dichromate, and potassium dichromate with sulfuric acid added. He did not obtain any chromium deposits.

In each test Buff operated a hydrogen gas coulometer with sulfuric acid in series, and found that the oxygen at the anode in the chromic acid solutions was exactly half the volume of the hydrogen in the coulometer. He therefore concluded that Geuther must have been in error in reporting excess oxygen at the anode, and that probably Geuther had not calibrated the "tangent compass" type of galvanometer which he used to measure the current, with sufficient care. Geuther later[7] admitted the correctness of this observation, but protested that it did not affect the correctness of the other conclusions which he had drawn, which were not based on the measurements of the current. Nevertheless, it appears that his work was so thoroughly discredited that no one believed that he had obtained deposits of metallic chromium from chromic acid solutions. Had not Professor Buff shown that this could not be done?

Actually Buff observed heavy reduction to trivalent chromium at the cathode in his experiments, and that it was favored by sulfuric acid additions. If Buff had used higher current densities or smaller additions of sulfuric acid, he might have obtained some chromium deposits, and the history of the subject might have been different. Buff made a further investigation,[8] but again did not get a deposit of chromium metal.

It may be of interest that Geuther also deposited metallic chromium from chromic chloride solution (reference 4, page 330). Such deposits were again mentioned in a footnote in a later article.[9]

At this late date one can also compute Geuther's current efficiencies from his careful measurements of the volume of oxygen at the anode. The results are as follows:

I. 22.6 Per cent
II. 21.5 Per cent
III. 33.2 Per cent
IV. 33.2 Per cent
V. 31.7 Per cent
VI. 38.8 Per cent
VII. 34.0 Per cent

These values are entirely reasonable since Geuther's solutions were cold. He used 50 g/l chromic acid solutions in experiments I and II, 100 g/l in III, IV, and V, and about 143 g/l in VI and VII. He states that the chromium deposited in the form of a coherent, metallically-bright, gray-white coating. His conclusion would seem to be more or less justified:

". . . that chromic acid in aqueous solution is an electrolyte, and indeed it is decomposed in such a way that an oxygen evolution occurs at the anode, while on the contrary at the cathode a complete reduction to metallic chromium takes place, along with the evolution of hydrogen gas and a partial reduction of some of the chromic acid."

VARIOUS INVESTIGATIONS, 1856-1920

The next to report on the electrolysis of chromic acid solution was F. Morges in a calorimetric study of the elec-

Dauer = 1 geliefert hätte; der Bruch $\frac{O}{J \cdot D}$ die gefundene Sauerstoffmenge für einen solchen Strom, und $\frac{H}{J \cdot D}$ die gefundene Wasserstoffmenge. Die Werthe der Gewichte von Cr, O und H sind in Milligrammen ausgedrückt.

Ermittelung des metallischen Chroms. — Dasselbe schlug sich in Form eines zusammenhängenden metallisch-glänzenden, grauweifsen Ueberzugs auf dem als Kathode dienenden Platindraht nieder. Seine Menge konnte leicht, nachdem der Platindraht aus der Röhre gesprengt worden war, durch dessen Gewichtszunahme gefunden werden.

	J	Cr	D	$\frac{Cr}{J \cdot D}$
I	0,7801	3,00	1177	0,003267
II	0,7801	2,20	881	0,003201
III	1,822	9,00	1136	0,004348
IV	1,909	7,00	891	0,004115
V	1,909	6,00	776	0,004050
VI	3,526	10,50	696	0,004278
VII	3,307	9,20	660	0,004215

Geuther's report of his seven experiments in 1856[4] showing the weight of chromium deposited in milligrams and the duration of the test in seconds. "J" was the deflection of the magnetic needle on his "tangent compass" galvanometer used to measure the current.

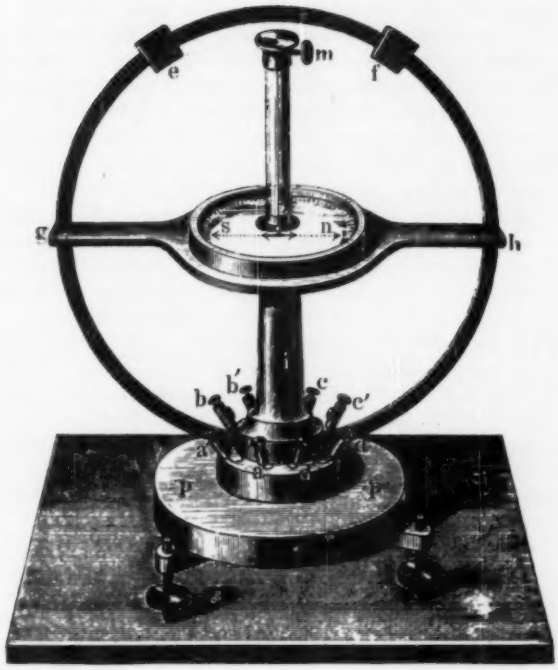
Das Resultat aus diesen Versuchen ist nun, *dafs die Menge des ausgeschiedenen Chroms nicht blofs von der Intensität und Dauer des Stroms abhängt, sondern auch von der in der Flüssigkeit enthaltenen Chromsäuremenge, und zwar scheint dieselbe einen Maximalwerth zu erreichen, wenn 1 Th. Chromsäure auf 10 Th. Wasser angewandt worden waren (III).* Es ergiebt sich ferner, dafs der nämliche Strom aus schon einmal zur Electrolyse benutzten Chromsäurelösungen immer weniger Chrom ausscheidet; oder mit andern Worten, dafs *die reducirte Chrommenge in einem umgekehrten Verhältnifs zur Dauer des Stroms steht.*

Bestimmung des Sauerstoffs. — Von besonderer Wichtigkeit für die Frage, ob eine directe Zersetzung der Chromsäure durch den Strom möglich sei, war die Messung des Sauerstoff-

trolysis of chromates.[10] Morges obtained only hydrogen and formation of chromium chromate at the cathode.

A few years later, in 1883, two Italian workers reported that they obtained bright chromium plate on a carbon cathode used in a study of the electrolysis of chromic acid solutions with carbon electrodes.[11] However, this report seems to have attracted little attention at that time.

In the 1890's a substantial effort was made by E. Placet and J. Bonnet of Paris to commercialize the electrodeposition of chromium. These inventors were in some way connected with two others, J. F. L. Moeller and E. A. G. Street, and with a company formed in London, England, the Electrometallurgical Company, Ltd. The numerous patents which were granted relating to chromium deposition from trivalent solutions will not be reviewed here. The patents did not give sufficient details of any process which could be checked by other workers, and were the subject of much criticism. It will suffice to merely examine briefly the patents relating to the use of chromic acid solutions.



"Tangent compass" type of galvanometer used by Geuther for current measurements. From G. Wiedemann, "Galvanismus und Elektromagnetismus," 2nd edition, volume 2, page 221, 1873.

On November 28, 1892 Emile Placet gave a short description of his results to the Academy of Sciences in Paris.[12] He also exhibited a sample of metallic chromium weighing more than a kilogram (2.2 lb), some alloys of chromium, and some chromium plated brass ornaments. The kilogram of chromium was said to have been exhibited at the Columbian Exposition in Chicago in 1893, at the Worlds Fair in Paris in 1900, and at the St. Louis Exposition in 1904.

The question was raised by Le Blanc[13, 14] whether or not this kilogram of chromium was produced in the manner claimed. However, Le Blanc failed to investigate the deposition of chromium from chromic acid solutions. Bancroft stated[15] later on that ". . . Placet and Bonnet exhibited in Paris metallic chromium obtained by electrolyzing chromic acid. . . .".

Placet and Bonnet applied for three French patents on July 17, 1891 which are of interest. One had to do with electrodepositing chromium from various chromium salt solutions,[16] but included a bath containing 100 to 150 g/l of alkaline chromate or bichromate and 150 to 200 g/l of chrome alum. It is stated that chromic acid may be used in place of chromates; the reaction is the same, but the bath is more expensive. The inventors speak of a chromate solution as the bath, and state that a solution of any sulfate may be added to it. The British patent decreases the amount of chrome alum to 100 to 150 g/l. A list of other chromium salts which may be used in place of chrome alum is given.

A second French patent relates to chromic acid baths.[17] These are stated to consist of as little as 10 to 20 g/l chromic acid, but the more concentrated the solution, the more abundant is the deposit. The appearance of the deposit may be varied by adding from 5 to 10 g/l of various acids listed. The chromic acid may be produced in the bath itself by using bichromate and adding successive small quantities of acid such as sulfuric acid. The French patent also states that they ". . . particularly make use of the chromic acid obtained by means of electricity with the aid of our patented process." The Swedish patent discusses the difficulty of polishing the very hard chromium deposits, and states that they may be given a desired appearance by adding from 1 to 10 g/l of an acid selected from the lists given.

A third French patent in this group describes a process for the preparation of pure chromic acid.[18] This consists of electrolyzing a solution of alkali chromate or bichromate with insoluble electrodes, with the cathode enclosed in a porous diaphragm. The alkali collects in the porous diaphragm and chromic acid is liberated at the anode. The chromic acid is recovered from the anolyte by recrystallization, and is stated to be free from all foreign acid and especially suitable for chromium deposition.

Later on more complete Belgian[19] and American[20] patents were granted which were something of a combination of the above French patents and others. Claim 2 of the Belgian patent covered specifically the chromium plating of wires and carbons used in electric lighting. The American patent was very definite with regard to the chemicals used in making up chromium plating baths, stating that: "The most important of these compounds is chromic acid, either the commercial acid, or chromic acid obtained from chromate or bichromate of an alkali metal."

In 1899 Reese[21] investigated the action of chromic acid on hydrogen, and also studied the action of electrolytic hydrogen. He found that pure chromic acid or potassium bichromate solutions were not reduced electrolytically at all, but that the slightest trace of sulfuric acid or a sulfate caused reduction. However, he did not report observing any chromium deposition.

Luther[22] electrolyzed chromic acid solution with a chromium anode and platinum cathode, but obtained only hydrogen at the cathode.

In 1905, Carveth and Curry[23] made a careful investigation of the work of Geuther and Buff while studying at Cornell University under Bancroft. They confirmed Geuther's work and concluded that both Buff and Geuther had used impure chromic acid, and that Buff's current densities were probably too low to give him any chromium deposit. However, they found that pure chromic acid could be reduced and would give chromium deposition—an incorrect conclusion in the light of present knowledge. This actually shows that their chromic acid was not as pure as they thought.

Carveth and Curry made a number of tests electrolyzing 3 cubic centimeters of solution at a time with 0.5 ampere. They plated a substantial proportion of the chromium out of their solutions, and reduced a good deal of the remaining chromic acid. They found that the current efficiency invariably fell off rapidly to relatively low values under these conditions. Their tests did show considerably increased chromium deposition with additions of sulfuric acid, potassium sulfate, nitric acid, hydrochloric acid, and potassium chloride.

Carveth and Curry also concluded that some of the claims of Placet and Bonnet were sound. This put them in conflict with many other workers of the period, as practically all tests of the Placet and Bonnet procedures were negative.

Carveth and Curry felt that methods for chromium deposition could be devised as soon as commercial demands warranted, but that because of the low current efficiencies in

XV. ***Elettrolisi delle soluzioni di acido cromico.*** **Con soluzioni assai ricche di acido, si ha appena sviluppo gazoso dallo elettrodo negativo: il carbone si consuma rapidamente, e se è di storta o di legna con regolare assottigliamento. Se s'impiega grafite, questa si rigonfia nella parte immersa e dopo poche ore si disfà completamente. Nel primo caso si ottiene mellogeno e nel secondo ossido grafitico: nel liquido non si trovano che tracce di acido mellico (1).**

(1) L'elettrodo negativo di carbone, impiegato nella elettrolisi dell'acido cromico, si trovò rivestito da una guaina di cromo metallico, tenacissimo, splendidissimo, inalterabile all'aria e dall'acqua: derivante dalla decomposizione del cromato di cromo formatosi nell'elettrolite.

Bartoli and Papasogli's report in 1883.[11] The footnote states: "(1) The negative electrode of carbon used in the electrolysis of chromic acid was found coated with a deposit of metallic chromium which was tenacious, bright, and non-tarnishing either in the air or in water; it resulted from the decomposition of the chromium chromate formed in the electrolyte."

chromic acid solutions, the trivalent sulfate or chloride baths offered more promise.

Brochet and Petit[24] found that chromic acid solutions were reduced when electrolyzed with superimposed alternating current, but did not note any chromium deposition. They did not get any reduction of chromates unless sulfuric acid was added.

A noteworthy effort to develop a satisfactory chromic acid bath for chromium deposition was that of Dr. Franz Salzer of Budapest, beginning in 1907. Salzer's first patent[25] covered a bath containing chromic acid and chromic oxide in the proportion by weight of 2:1 to 1:1, preferably about 4:3. A small amount of an electrolyte such as a little acid may be added, but large amounts of conducting salts as used in other baths must be avoided. The proportion of chromic acid to chromic oxide can be maintained constant by the use of insoluble anodes of magnetite (Fe_3O_4), lead, or platinum, partially separated from the cathode by a diaphragm. The solution was used cold with a current density of 2 to 5 amp/sq dm (19 to 47 amp/sq ft) and 3 to 6 volts. Salzer thought that pure chromic acid could be reduced electrolytically to form his solution.

An Austrian patent[26] differed from the others in claiming that a bright plate could be produced if less thickness was satisfactory, by increasing the chromic acid to a 3:1 ratio.

In a later patent[27] Salzer reported improved results if a simple chromic salt was added such as chromic sulfate or chloride, preferably chromic sulfate, but not in a quantity exceeding that of the chromic acid or chromic oxide. Double salts of chromium or chrome alum are not to be recommended as the ammonium or alkali ions migrate to the cathode and are injurious. With the chromic sulfate addition one can also about double the chromic acid concentration, and denser deposits are obtained at higher current efficiencies and lower current densities. An example is given of a bath containing 11 per cent Cr_2O_3, 13 per cent CrO_3 and 12 per cent $Cr_2(SO_4)_3$.

Salzer's primary purpose was the chromium plating of wire supports for metal filaments in electric light bulbs, and he was granted a patent on this use.[28] The patent claimed heat treating the chromium plated wires prior to use in order to get some oxidation and alloying. A dull chromium plate containing oxide was preferred for this use.

When Liebreich stated in an article in 1927[29] that Salzer's process had not made possible the industrial application of chromium plating, Salzer published a protest[30] in which he stated that: "It was made use of in the incandescent lamp industry, in which nickel wires coated with chromium found application in place of platinum as supports for tungsten filaments. Many million lamps have been produced by my process in Austrian, German and English factories."

Salzer's process as disclosed in U. S. 900,597 was checked by F. Foerster,[31] who obtained good results. In 1915 Foerster recommended the bath of the second Salzer patent[27] in his book (reference 32, page 491). In the third and fourth editions in 1922 and 1923, Foerster mentions in addition that Salzer's solution only gives thin deposits (page 560). Aten obtained chromium deposits in 1918[33] using Salzer's bath as recommended by Foerster. Hughes worked with Salzer's bath, and obtained "only fair" results.[34]

Another important investigation was that of Jean Voisin in Paris in 1910.[35] Voisin's results appear to have been largely overlooked by later investigators. Schneidewind's reviews[36, 37] barely mention Voisin's work, and apparently Schneidewind was unaware that Voisin had investigated chromic acid solutions in addition to bivalent and trivalent baths.

Voisin checked and confirmed the work of Carveth and Curry. The best concentration of "ordinary" chromic acid containing some sulfuric acid was found to be 260 g/l. With this solution Voisin obtained a white and adherent deposit with a current efficiency of 6.45 per cent which he considered very low. Voisin now tried the electrolysis under the same conditions of a chromic acid sold as being "pure," but could only obtain a very slight deposit of metal. He found that this "pure" chromic acid contained a little sulfuric acid, and proceeded to purify it before preparing a third solution.

Voisin purified the chromic acid by melting it carefully several times in a platinum crucible to avoid decomposition. Under these conditions the sulfuric acid forms a separate layer due to a difference in surface tension, and pure chromic acid collects in the bottom of the crucible. Using this special purity chromic acid at the same concentration as before, Voisin was unable to obtain the least trace of metal, even at higher current density. The electrolysis behaved exactly like that of sulfuric acid and there was no reduction or oxidation, and only hydrogen and oxygen appeared at the electrodes. Voisin therefore concluded that chromium deposits could only be obtained from chromic acid by adding sulfuric acid; and that the proces included two simultaneous electrolyses, that of chromic acid with evolution of gas, and that of a chromic salt with metal deposition at the cathode.

Voisin further concluded that he had not obtained results of practical value by the electrolysis of chromic acid solution, and agreed with Carveth and Curry that this electrolysis is merely a scientific curiosity.

Max Baum in Germany in 1912 obtained a patent[38] on chromium plating filament holders, similar to the patent of Salzer.[28] Baum claimed to get a coating of chromium containing admixed chromous hydroxide which he converted to chromic oxide by heating in hydrogen. He used a bath containing 10 per cent chromic acid and 0.5 to 1 per cent of an acid such as boric acid or tartaric acid. If the current density is not too high, a solution containing 10 per cent chromic acid and 10 per cent chromic sulfate, and some boric acid, may be used. Baum mentions using 0.2 amp/sq cm (200 amp/sq ft) and about 20 volts.

Askenasy and Revai in Germany in 1913 also obtained numerous undesired chromium deposits in the course of their study of the electrolytic oxidation of chromic sulfate to

chromic acid.[39] They were diverted to the study of chromium deposition to some extent, and confirmed Carveth and Curry's conclusion that the yield of chromium is low from sulfuric acid free chromic acid solutions, and much better when the chromic acid solution contains sulfuric acid or other impurities.

Wilhelm Rathert in Germany published a paper in 1914[40] in which he studied the passivity of iron, nickel and chromium, and used both ordinary Goldschmidt chromium and electrolytic chromium. Rathert succeeded in plating platinum and chromium electrodes with electrolytic chromium by means of Carveth and Curry's procedure.

SARGENT'S WORK

George J. Sargent graduated from New Hampshire State College in 1909, and after three years of graduate work at Cornell University under Bancroft, received his PhD degree in 1912. He held a fellowship at Cornell for two years more, until 1914, in order to continue research work on chromium deposition.[41] The results of this work were not published until 1920.[42] In the meantime Dr. Sargent was employed at the Michigan Smelting and Refining Company in Detroit from 1914 to 1917; Connecticut Metal and Chemical Company, New Britain, 1917 to 1920; and Dodge Brothers Motor Car Company, Detroit, 1920 to 1921. So far as is known, no effort was made to do chromium plating commercially during this period. Dr. Sargent recently retired from his home and laboratory in Pittsfield, N. H. to Santa Barbara, California.

Dr. Sargent's systematic investigation of chromium deposition might be said to mark the beginning of the modern period in the development of this process. In it we can see the beginnings of many more recent developments, both theoretical and practical. However, he did not disclose a process of chromium plating ready for commercial use, as so many later workers have tried to maintain. In the discussion to Dr. Sargent's paper in 1920 (reference 42, page 496) Professor Bancroft said: "It was a long time ago; what we had hoped to do was to plate on iron and then heat in hydrogen and get a chrome steel surface. . . . chromium does not alloy with iron until you get up to 1200C, which is too near the melting point to be safe. That was the reason we dropped the thing."

Sargent electrolyzed solutions of various mixtures of chromic acid and chromic sulfate with varying temperatures and current densities, and with and without agitation. He was more concerned with the electrolytic production of the metal with good efficiency, than with plating. If one computes his current efficiencies one finds that they are mostly in the range of 30 to 40 per cent, with very few below 20 per cent. A great deal of the work was done at temperatures around 10C (50F) and below, presumably to get high efficiency. The highest temperature investigated was 35C (95F), but it was concluded that: "The deposits obtained at the lower temperatures and lower current densities were as good, if not better, than those obtained at a temperature of 35°."

Later on, reference was frequently made to "Sargent's solution," but Dr. Sargent did not recommend a specific formula in the article published. The closest approach was the statement in the main investigation that a solution of 22 per cent chromic acid and 0.5 per cent chromic sulfate gave the best results. However, in a further investigation of the maximum thickness which could be obtained before treeing occurred, this solution only gave a deposit a little over ⅛ in. thick, while a solution containing 25 per cent chromic acid and 0.3 per cent chromic sulfate used at 20C (68F) and 10 amp/sq dm (93 amp/sq ft) gave a deposit almost 0.5 in. thick, the best obtained. In the summary, this latter solution and conditions were recommended, although the formula appeared as 24.5 per cent chromic acid and 0.3 per cent chromic sulfate.

Dr. Sargent used Baker and Adamson's C.P. chromic acid in most of his work, and felt that it was essentially pure chromic acid because of its high assay in chromium. However, this chromic acid was generally reduced by the action of the current, and even gave some chromium deposition at very high current densities. In the light of later knowledge this shows that the C.P. chromic acid probably contained some sulfate or other acid radicals.

Since there was no chromium deposition from the chromic acid at moderate current densities, Dr. Sargent felt that chromium did not deposit from the hexavalent stage, but from the trivalent chromium present. He therefore felt that it was important to maintain a certain concentration of trivalent chromium ion to get good deposition. This thought was predominant in the minds of most workers for at least 5 or 6 years after the publication of the Sargent article in 1920.

FROM SARGENT TO FINK, 1920-1925

In order to highlight the scramble to discover the basic factors controlling the deposition of chromium from chromic acid solutions which occurred in 1920 to 1925, the various publications and patents will be reviewed as of their date of receipt or date of filing, rather than the date of publication or issuance, which in some cases was many years later. Thus various workers generally were not aware of the results of others working at the same time until publication occurred.

Simultaneously and independently of the publication of the Sargent article, Dr. Erik Liebreich began an extensive investigation in Berlin, Germany. Dr. Liebreich was a professor and industrial chemist who had obtained some patents and established a company for making corrosion resisting paints, among other things. He was 36 years old in 1920, and died November 24, 1946 at 62.[43]

In a patent filed October 23, 1919, Dr. Liebreich gives an example of chromium-iron alloy plating in which he suggests the use of a 3N chromic acid solution with iron anodes.[44] His "main patent" on chromium plating was filed March 8, 1920,[45] just a month before the Sargent article was published. In it Dr. Liebreich gives a typical decomposition potential curve for the electrolysis of chromic acid, which is divided into four branches. Chromium was only found to deposit on the fourth branch which occurs at the highest current densities. Dr. Liebreich made a big issue of the theoretical explanation of the four branches of his curves, and the periodic fluctuations of current and voltage between them, which we now know were due to the sulfate impurity in the chromic acid he used. Later on these periodic fluctuations came to be known by such terms as "pulsations" or "valve action," and were taken as an indication that the solution had too high a sulfate content.

Dr. Liebreich claimed that he could eliminate the periodic fluctuations and obtain a good chromium plating bath by collecting reduced solution formed on the third branch of the curves, and containing tri- and bivalent oxides, and little or no chromic acid. The addition of trivalent chromium com-

Dr. Erik Liebreich (1884–1946) about 1928.

pounds and of boric acid was sometimes found to be helpful. Dr. Liebreich did not disclose just how to make up his chromium plating bath, and later workers were unable to duplicate his decomposition potential curves. Actually, he performed many of his experiments in a U-tube, and reduced solution would collect around the cathode in the cathode arm of the tube, and not be reoxidized by the anode.

Three patents of addition to this main patent were filed later on. One[46] claimed the production of the reduced chromic acid bath by first melting the chromic acid containing a slight amount of "free acid" such as sulfuric acid, under exclusion of air at about 170C, until the chromic acid was sufficiently reduced. The chromic acid used should not contain over 7 or 8 per cent of free sulfuric acid, preferably 2 to 4 per cent. The complete exclusion of sulfuric acid is not beneficial or the cathode may become coated with colloidal oxides which make metal deposition difficult. An addition of free acid may be made after the bath is made up in order to prevent the deposition of these colloidal oxides. The fusion process used in this patent obviously appears to be a means of purifying the chromic acid and freeing it from excess sulfuric acid or sulfate, as was done by Voisin in 1910.

In the second patent of addition,[47] Liebreich claims the production of the bath in the cathode compartment of a two-compartment cell using large cathode area, a cathodic arc, controlled cathode current density, and agitation. It is also claimed to be helpful to plate in a warm solution, 30 to 50C, especially in very concentrated baths or those in which the acidity is not adjusted most correctly.

A third patent of addition was not filed until 1926,[48] and related to the use of organic matter or carbon, or finely divided aluminum or magnesium, to reduce the chromic acid. The reduction is preferably made by adding the material to molten chromic acid.

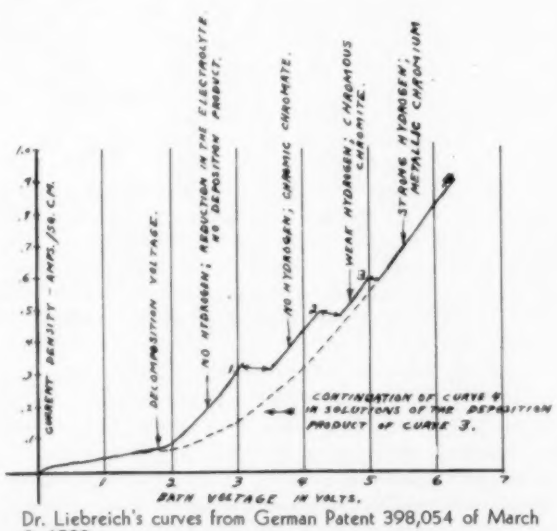
On June 14, 1920 a long article was received from Dr. Liebreich by the magazine Zeitschrift fuer Elektrochemie, but this was not published until March 1, 1921. A brief description was submitted to another magazine, Naturwissenschaften, in July, 1920, and appeared in the Sept. 10, 1920 issue.[49] In the first half of the longer paper[50] Dr. Liebreich describes his theories of the pulsations and measurements at great length, without even coming to the discussion of chromium deposition until the latter part. He says that he accidentally came to observe these phenomena during the course of a less important investigation on the potentials of gas-free metals. He used various concentrations of pure crystallized chromic acid from the firm of Merck in Darmstadt.

The article goes on to describe many of the same features covered by the above patents. These include collecting reduced solution on the third branch of the curves at less than the current density for chromium deposition, or reducing the chromic acid by fusion, to get a solution in which the periodic phenomena are eliminated, and chromium deposition occurs at low current densities. Dr. Liebreich speaks of cathodically reducing the solution until some precipitation of chromic oxide occurs, and perhaps this resulted in some purification of his solutions.

Dr. Liebreich also described an investigation of trivalent solutions, but these did not give as good results as the reduced chromic acid. Good results were also obtained from an alkaline bath containing excess caustic, and this was patented.[51] The writer tried this alkaline solution but could not get any chromium from it; probably it gave Liebreich a film of some other metal present as an impurity, such as iron or zinc. Another special patent was filed on July 11, 1920 by Dr. Liebreich on the use of chromium plate on glass cutters.[51a]

Another German college professor who developed a chromium plating process at this time was Dr. Georg Grube. Dr. Grube's German patent was filed July 19, 1921,[52] and covered a bath which seemed based upon the Sargent article. Dr. Grube stated that Sargent's solution gave deposits that were too porous, and claimed baths in which the ratio of chromic acid to chromic oxide plus foreign acid was greater than 2:1, and in which the chromic oxide was more than sufficient to neutralize all of the foreign acid present. Two examples of satisfactory chromium plating baths were given —one contained 415 g/l chromic acid, 21 g/l chromic sulfate, and 12 g/l chromic hydroxide; the other was 250 g/l chromic acid, 3 g/l chromic sulfate, and 6 g/l chromic hydroxide.

Dr. Grube's patents in other countries were in the name of Fried. Krupp A. G.[53] They varied somewhat, but need not be discussed here. The American patent[54] was assigned to Metal and Thermit Corporation, and to its subsidiary formed later and called Chromium Products Corporation.


CURRENT DENSITY - AMPS./SQ. CM.
DECOMPOSITION VOLTAGE.
NO HYDROGEN; REDUCTION IN THE ELECTROLYTE AS DEPOSITION PRODUCT.
NO HYDROGEN; CHROMIC CHROMATE.
WEAK HYDROGEN; CHROMOUS CHROMITE.
STRONG HYDROGEN; METALLIC CHROMIUM
CONTINUATION OF CURVE 4 IN SOLUTIONS OF THE DEPOSITION PRODUCT OF CURVE 3.
BATH VOLTAGE IN VOLTS.

Dr. Liebreich's curves from German Patent 398,054 of March 8, 1920.

Dr. Liebreich published a second article later in 1921[55] which dealt with the effect of chlorides on the decomposition potential curves of chromic acid. He was trying to show the colloidal nature of the oxides or hydroxides formed at the cathode, and tried additions of sodium chloride, potassium chloride, and hydrochloric acid. The addition of hydrochloric acid had a stronger effect than the salts, and required a higher current density to get chromium deposition. Dr. Liebreich ascribed this to the effect of the hydrogen ion (he considered chromic acid solutions more or less neutral). In the light of later knowledge, it is evident that the hydrochloric acid probably introduced a larger quantity of chloride ion than the salts, and this had a greater effect on chromium deposition.

Dr. Liebreich appears to have only published one article in 1922,[56] which merely summarized and reiterated his position. Two sets of curves are again published, the one showing the periodic fluctuations in chromic acid solutions; the other their elimination, and chromium deposition at low current densities in reduced baths. It is mentioned that an Elektro-Chrom GmbH had been formed in Berlin to further investigate the desirable properties of chromium coatings. Good results are reported for the corrosion resistance of chromium deposits, and commercial use of the process is indicated. A translation of most of this article appeared,[57] along with other comments.

Dr. Liebreich filed a patent application in Germany on March 28, 1923[58] which was not granted, but corresponding patents were issued in several other countries.[58–60] This patent is of interest in that it points out that brighter deposits are obtained by plating at 30 to 50C than at room temperature. The bath used is still considered to be a mixture of bivalent and trivalent oxides containing little or no chromic acid, and only qualitative reference is made to "acidifying" it to various degrees. The high degree of reduction of the bath may be obtained by fusing chromic acid or a chromate, and this procedure is claimed.

Dr. Liebreich published another paper May 1, 1923[61] in which he compares Dr. Sargent's theories to his own. He gives cathode potential-current density curves for chromic acid solutions made from chromic acid containing 8.1 per cent sulfuric acid and some containing only 0.042 per cent sulfuric acid. The purer chromic acid gave chromium deposition at quite low current densities, and the four branches of the curves could not be seen. This explains why Dr. Sargent thought there were only two branches to the curves, one for reduction and the other for chromium deposition and hydrogen evolution.

Dr. Liebreich also gives curves on his reduced chromic acid bath, both at room temperature and at 40C, to show the four branches of the curves corresponding to reduction in three stages. He elaborates at length his theory that chromium is deposited from the bivalent ion, and that this is the controlling factor.

In 1922 and early in 1923, Professor Colin G. Fink at Columbia University assigned one of his students, Kevie W. Schwartz, to investigate chromium deposition. Dr. Fink had made preliminary investigations as early as 1905, and was fully aware of the potentialities of this field. According to his thesis,[62] Mr. Schwartz first investigated various trivalent chromic sulfate solutions starting on Feb. 26, 1923, but the results were poor. Good results were obtained in runs No. 10 and 11 on March 26, 1923 with a Sargent solution consisting of 245 g/l chromic acid and 3 g/l of chromic sulfate. Varying the concentration of chromic acid from 200 to 400 g/l was next tried, with other conditions constant, and good deposits were obtained anywhere within this range. No details of these tests are given but it was concluded that 245 g/l chromic acid and 3 g/l chromic sulfate was best, and all further tests were made with this composition. Chromium anodes were found to dissolve well and were recommended.

Schwartz made further tests to check the effect of varying temperature and current density. He also checked the corrosion resistance of the deposits to various media, and electrolytic corrosion properties likewise. Another test checked the effect of adding 2.5 cc of concentrated sulfuric acid per liter. No deposit was obtained under the usual conditions and it was necessary to use a higher current density to get even poor and slow plating. The chromic acid used by Schwartz contained 1.67 per cent sulfate.

Schwartz's thesis was dated May 23, 1923, and apparently Dr. Fink abstracted it immediately as an American Electrochemical Society paper. It was issued as a preprint not long after, and stirred up considerable additional interest in the subject.

The discussion to Schwartz's paper[63] disclosed that the Westinghouse Lamp Company, Eastman Kodak Company and Bureau of Standards had been working on chromium plating. It also disclosed how little was known regarding the process in 1923. Schwartz graduated from Columbia University at this time and entered the employ of Metal & Thermit Corporation.

Another outstanding publication in the summer of 1923 was a short article by Dr. W. Pfanhauser.[64] This announced that the Langbein-Pfanhauser Werken A. G. was selling Dr. Liebreich's process, and gave a long list of special uses for chromium plate.

A. J. Coignard of Paris filed a patent application Oct. 3, 1923,[65] which gave a vague description of a chromic acid bath, and related to the use of ferrochromium anodes. The addition to this patent filed May 27, 1924[66] was a little more definite, specifying 10 to 50 per cent concentration for the "chromium salt," and the addition of hydrochloric, sulfuric, or other acid up to 2 per cent. The 2 per cent concentration is specified for a temperature of 80C; with temperatures refrigerated below room temperature the acid addition may be decreased to as low as 0.1 per cent. The deposits from 1 to 20C are dull and bluish; from 30 to 80C they are white metallic with the appearance of silver.

In October, 1923, Anton Kleffner of Munich published[67] a criticism of Liebreich's work, explaining that the periodic fluctuations were perhaps caused by a sulfuric acid impurity in the chromic acid used. Kleffner's student, Miss Callenberg had proven (Dissertation Munich 1917—not published) that there were no periodic fluctuations if the chromic acid contained no sulfuric acid. Kleffner tried some pure crystallized chromic acid of Kahlbaum, but it gave no periodic fluctuations, and only a black deposit on the cathode. The results were entirely different with a solution of Merck chromic acid which Liebreich had used, and which gave the same periodic phenomena. Analyses showed that the Merck chromic acid contained considerable sulfuric acid, while the Kahlbaum was pure by comparison. It appeared that Liebreich's periodic phenomena could be produced by adding sulfuric acid to the Kahlbaum chromic acid, and this was found to be the case. Detailed experiments are reported with varying quantities of N/10 sulfuric acid added.

Immediately following Kleffner's paper was one by K. Oyabu[68] which compared Sargent's and Liebreich's decom-

position potential curves and showed that Liebreich's curves were normal for platinum electrodes and Sargent's for copper or chromium plated copper electrodes. Oyabu also explains Liebreich's extra curve on platinum as due to the low hydrogen overvoltage on this metal, which gives an extra curve of hydrogen evolution before chromium deposition begins. He points out that bivalent chromium compounds could not exist in the body of the solution, as they would be immediately oxidized by the chromic acid.

Oyabu must have worked with impure chromic acid as he obtained considerable reduction and chromium deposition with it with no additions. He very wisely concludes that while he feels that he has explained the curves obtained, we still have to explain the deposition of metallic chromium.

N. Bouman worked on the electrolytic preparation of chromium electrodes for passivity studies in 1923.[69] He tried successively the methods published by Bunsen, Neuman, Carveth and Curry, Liebreich, and Sargent. It appeared to be very difficult to obtain good deposits of chromium. He was finally able to achieve this purpose by Sargent's method.

On December 5, 1923, Dr. V. Yngve, assignor to Manhattan Electric Supply Company, Inc., applied for a patent on chromium plated steel forming tools.[70] Dr. Yngve merely used "Sargent's Solution" of 245 g/l chromic acid and 3 g/l chromic sulfate. He also obtained a later patent[71] on chromium plated electrical contact surfaces. The Manhattan company was engaged in developing a dry cell assembled from washers of the manganese dioxide mix,[72] and chromium plated tools were useful for stamping out the washers. The writer was employed on this project from January through May, 1925, but not in connection with chromium plating.

In January 1924,[73] Liebreich mentioned that his process had already found industrial application in Germany, but that he had not heard of similar activities abroad. He gives a brief comment on Schwartz's paper, and on one by Kelly on chromizing.

Dr. Liebreich published a number of other articles in 1924, but none of much importance for the development of chromium plating. On March 15 he commented rather caustically on an anonymous review of such publications as those of Kleffner and Schwartz.[74] In April he replied to the criticisms of Kleffner and Oyabu.[75] A review of the properties and uses of chromium plate was published in May, 1924.[76] An English article[77] emphasized his theory that chromium plating required the presence of some bivalent oxide, and warned that any process using chromic acid would involve his theory. Other articles dealt with the electrochemical properties of chromium metal.[78–80]

Dr. Wilhelm Pfanhauser published an appendix to the 6th edition of his book, on Apr. 16, 1924, in which he reviewed many aspects of the technique of practical chromium plating.[81] The 6th edition originally appeared in February 1922, and only recommended Salzer's bath on pages 537–538. Dr. Salzer had been a chemist in the employ of Dr. G. Langbein & Co., a forerunner of the Langbein-Pfanhauser Werke A. G. The new appendix to the book reviewed the work of Liebreich and Sargent in a favorable light. Pfanhauser worked with Liebreich for a time, then split off, and then still later joined in a group under the German patents on chromium plating, the Chrom-Interessen-Gemeinschaft.

Pierce and Humphries applied for a patent on May 5, 1924[82] which was claimed to be an improvement on "Sargent's solution," in that they added the chromium sulfate to the chromic acid in the form of a slurry made by dissolving the chromic sulfate in water and precipitating with ammonium hydroxide. The resultant solution was claimed to be ready for use without aging, and "Sargent's solution" was said to require aging. This patent along with others formed the basis of a serious attempt to commercialize chromium plating by the Metals Protection Corporation of Indianapolis.

In May, 1924, Mr. C. M. Metch published his formulas for chromium plating baths.[83] These were variations of Sargent with the addition of boric acid, and one was stated to be for barrel plating.

In June, 1924,[84] Dr. J. Silberstein of Westinghouse Electric & Mfg. Co. published a commentary on the Schwartz article and on one of Liebreich's.[61] Silberstein seems to accept Liebreich's point of view and treats chromic acid baths as neutral, and the additions to them as causing an important variation in the hydrogen ion concentration.

Probably also in June, 1924, Marc Wantz published his thesis at the University of Geneva.[85] Abstracts appeared a few months later.[86] Wantz made a rather complete investigation of both chromic acid and trivalent solutions, without contributing much that was new. He used a Sargent formula, and also studied the effect of iron additions with a view to the use of ferrochromium anodes. He concluded that iron was injurious and that ferrochromium presents some very great difficulties. Wantz's purpose was the production of chromium metal rather than plating. He got poor results with trivalent baths, and better with chromic acid solutions.

Carl Hambuechen filed a patent on July 5, 1924 which was of interest but did not teach how to do chromium plating.[87] He used baths of 200–600 g/l chromic acid, preferably 300 g/l, to which he added 10 to 50 g/l of a fluoride, preferably sodium fluoride. Hydrofluoric acid did not work as well. Preferably the solution should not contain any sulfuric or hydrochloric acid or other mineral acid. Hambuechen also used a combination of five-sixths lead and one-sixth chromium anodes.

On July 21, 1924 Dr. Liebreich filed a patent[88] which became dominant in the German patent situation, and in which he finally expressed a rather definite amount of "free sulfuric acid" as best for chromium plating. It is mentioned that the required lower valent oxides or hydroxides cannot be obtained by reduction if the commercial chromic acid used contains too much free sulfuric acid, which has an oxidizing effect in combination with the chromic acid. This is the case if the chromic acid contains more than 1.2 per cent free sulfuric acid, and this is given as the upper limit permissible. It is stated to be better if the acidity amounts to only a few tenths of one per cent. Under these conditions, a short electrolysis at less than the current density for chromium deposition is sufficient to prepare the solution for plating. While the specification mentions only free sulfuric acid, the first claim covers chromic acid containing not more than 1.2 per cent of "free foreign acids." The second claim specifies preparing a solution by electrolysis at less than the current density for chromium deposition.

While this does not seem like a full, clear, and exact disclosure of a method of chromium plating, German patent law is rather different from American, and this patent was sustained by the German Courts. In an American patent application which did not issue, Liebreich specified ". . . the limits of 0.2 to 2 per cent of the chromic acid which is contained in the bath, if concentrated sulfuric acid is used, or in relative proportions in view of the hydrogen ions, if another acid or salts are used, which decompose into chromates and acids."

A different British patent[89] filed August 13, 1924 by Dr. Liebreich, was more specific. The baths were prepared by

using chromic acid containing less than 1.2 per cent free sulfuric acid, the chromic acid being reduced by melting prior to use. The proper concentration of bivalent oxides is obtained for bright plating by keeping the acidity and temperature high, while for grey chromium deposits the acidity and temperatures are kept low. Thus for bright plating the free acid, preferably sulfuric acid, should be 0.8 to 1.2 per cent of the chromic acid, and the temperature 40 to 50C. For dull deposits the sulfuric acid should be 0.6 to 0.8 per cent or less, and the temperature 15C.

Another German patent of this period was that of the Vereinigte Elektrochemische Fabriken Dr. Oskar Hahn, filed August 14, 1924.[90] This patentee claimed advantages for treating the chromic acid bath with the most powerful oxidizing agents such as hydrogen peroxide or potassium permanganate. (Actually these are reducing agents in chromic acid solution, and Dr. Liebreich's firm sued this company later.)

K. W. Schwartz applied for a patent on Nov. 11, 1924, on the use of chromium anodes in chromic acid baths, and especially the baths developed by Grube.[91]

G. LeBris of Paris stated in his patent application of Dec. 1, 1924[92] that chromic acid alone would not serve to give a chromium deposit, and that it was necessary to add some sulfuric acid or something which would form chromium sulfate in the bath. He states that he has developed a bath in which the chromic acid is no longer in the free state, and from which all traces of sulfate are rigorously excluded. The formula of his solution is $Cr_2O_3.4CrO_3.9H_2O$. Such a solution only gives oxides, and it is necessary to add an oxidant. He claims the addition of oxidizing acids or salts without specifying them. The British and Belgian patents mention the use of sodium perborate.

Becker and Hilberg in January, 1925[93] were unable to get satisfactory deposits from Carveth and Curry's directions. They did get good results from one of Kleffner's baths, 400 g/l of Kahlbaum chromic acid and 333 cc/l of 0.1 N sulfuric acid.

Suzuki applied for a patent in Japan on January 19, 1925.[94] He claimed a chromium bath consisting of 5 to 10 per cent chromic acid, 5 to 15 per cent chromic sulfate, and 5 per cent boric acid. Carbolic acid or glycerine may be used instead of boric acid.

King patented[95] the chromium plating of the interior of oil cracking stills. He used "Sargent's solution" consisting of 100 g/l chromic acid and 3.5 g/l chromic sulfate. He found that the chromic acid could vary from 50 to 350 g/l and the chromic sulfate from 2.3 to 3.75 g/l.

The Langbein-Pfanhauser-Werke A. G. applied for a patent on June 11, 1925[96] covering the addition of salts which hydrolyze to give a little acid or alkali, and thus serve as buffer substances and to control the hydrogen ion concentration of chromic acid baths. Iron, aluminum and magnesium compounds are given as examples, preferably the sulfates. An example is given of a bath containing 200 to 450 g/l chromic acid, 0.01 to 6 g/l trivalent chromic oxide, 1 to 3 g/l sulfuric acid, either added or coming from the impurity in the chromic acid, and 0.5 to 2 g/l of the hydrolyzing metal compound.

Dr. F. W. Wuerker of Leipzig developed a chromic acid bath and a patent was applied for in Germany on June 27, 1925.[97] Dr. Wuerker claimed a catalytic effect at the cathode for the cations of certain alkaline earth or heavy metal compounds (with the exception of chromium). He used 300 to 400 g/l of chromic acid, and 2 to 3 g/l of copper sulfate, nickel sulfate, cobalt sulfate, or iron sulfate, or the analogous chlorides or fluoborates, etc. Aluminum sulfate is also stated to give good results. The patents in other countries mention only copper and aluminum sulfates.

The General Motors Corporation applied for an American patent on July 6, 1925 which was not allowed, but the British and French patents were granted.[98] The inventors, W. M. Phillips and W. C. Strausser, claimed a bath containing 200 g/l chromic acid, 1 to 12.5 g/l of hydrated chromic sulfate, and 1 to 12.5 g/l of boric acid.

H. E. Haring of the Bureau of Standards wrote a paper which was presented by Dr. Blum at the American Electroplater's Society meeting in Montreal on June 30, 1925.[99] A more detailed article was published in August, 1925.[100] The discussion at the AES meeting[101] was interesting as further showing the circumstances at the time.

Haring felt that the erratic results with baths containing chromic acid and chromic sulfate could be eliminated by controlling the hydrogen ion concentration, and that this could be done by adding an excess of chromium chromate to act as a buffer. To do this he added chromium carbonate (the chromium carbonate was later[102] found to contain some sulfate, which accounted for its favorable effect). Haring's formula for the bath used at the Bureau of Engraving and Printing was:

chromic acid	250 g/l
chromic sulfate	3 g/l
chromic carbonate	7 g/l

J. M. Hosdowich of Metal & Thermit Corporation applied for an American patent September 10, 1925.[103] Hosdowich patented the addition of soluble salts of metals more negative than chromium, and gave as examples baths containing 325 g/l chromic acid, 12 g/l chromic hydroxide, and 6 g/l crystalline ferrous sulfate or nickel sulfate. The sulfates, chlorides, bromides, or carbonates, etc. of cadmium, tin, lead, antimony, bismuth, copper and mercury may also be used in quantities up to 30 g/l.

Another British patent application of Chromium Products Corporation and J. M. Hosdowich was not granted, but published.[104] This patent was similar to those of Liebreich, and emphasized maintenance of some chromium chromate or reduced chromic acid in the bath. A formula was given consisting of 50 parts by weight of chromic acid, dissolved in 100 parts by weight of water, 10 parts by weight commercial peroxide, 1 part sulfuric acid and 5 parts chromic sulfate.

J. D. Alley of Westinghouse Electric & Mfg. Co. applied for an American patent on September 12, 1925, which specified sulfate radical, but in excessive amount. This patent was not granted, but a British patent assigned to Metropolitan Vickers Electrical Company, Ltd. was granted.[105] Alley's formula was 150 g/l chromic acid and 4 to 8 g/l of sulfate. The sulfate radical could be added as sulfuric acid, or as a soluble sulfate such as sodium sulfate or chromic sulfate. This patent was not published until May 5, 1927.

E. A. Ollard of Metropolitan Vickers' Electrical Co., Ltd., published a noteworthy paper on Sept. 11, 1925.[106] However, he hardly discussed bath composition except to say that they used Dr. Liebreich's process with satisfactory results. Ollard published a more detailed paper February 10, 1926,[107] and described his theory of chromium plating at the time. He has also published many more recent papers.

G. M. Enos of the University of Cincinnati reviewed the work of several of his students, in a paper given on September 24, 1925.[108] Enos' student Salkover in 1922 had

obtained good results with 300 g/l chromic acid and 10 g/l chromic sulfate. The chromic acid concentration may be allowed to run down without harmful results and a somewhat higher concentration of chromic sulfate is permissible. Another student, Rengering, found in 1924 that the temperature should not be allowed to rise over 17C. Enos used a bath consisting of 245 g/l chromic acid, 3 g/l chromic sulfate, and 5 cc/l concentrated sulfuric acid, which he considered to be essentially Sargent's solution.

R. Appel applied for a patent in Germany Nov. 26, 1925 which was not granted, but which was allowed in several other countries.[109] Appel recommended a bath containing 50 g/l chromic acid and 0.5 g/l sodium sulfate. If a brown colloidal oxide deposits at first, this is a sign of too low acidity. Adding a few drops of sulfuric acid gives a pure deposit. Appel also obtained several later patents.

In December, 1925, Dr. Liebreich published a short note[110] commenting on publicity of Dr. Fink and The Chemical Treatment Company released in June, 1925. Dr. Liebreich was mildly critical, and claimed priority for himself and Germany.

On February 15, 1926, Dr. Liebreich published a rather severe criticism[111] of an article by Dr. Bilfinger of the Langbein-Pfanhauser-Werke A. G. and another by E. Kruppa of Chrom-Industrie Max Wommer. Dr. Liebreich threatened suits by Elektro-Chrom-GmbH against all infringers.

The above describes the situation when Fink and Eldridge set out to develop the process of chromium plating in 1923 to 1925. Of course the situation was partly engendered by their own activities and those of the Metal & Thermit Corporation group. The competition was keen, and everyone who was successful in obtaining chromium deposits from a Sargent type solution thought that he had discovered chromium plating.

The writer was one of these. He worked on chromium plating for two weeks in April, 1924, for Professor E. M. Baker at the University of Michigan. A series of steel test pieces were plated directly with chromium at 40C (104F) and about 150 to 200 amperes per square foot, and tested in the salt spray. The first piece was not salt spray tested as the current density on it was slightly lower, and gave periodic gassing and incomplete coverage. The salt spray tests were rated by Baker's method,[112] higher ratings indicating higher corrosion resistance (not to be confused with present ASTM ratings). The results were as follows:

	Chromium thickness	Salt Spray	
No.	Inches	hours	rating
1	(not tested)	—	—
2	0.00003	25.5	5
3	0.00006	17.0	3
4	0.00006	25.5	6
5	0.00015	25.5	5
6	0.00015	17.0	3
7	0.00030	17.0	2
8	0.00030	17.0	1

It appeared that the rust resistance actually decreased with increasing thickness. It was found that the chromium plate adhered to the steel, even if the surface was purposely greased beforehand. The chromium plate tended to cause nickel plate to peel if the nickel had insufficient adhesion. Copper and nickel plate would not adhere on top of chromium.

Electrolysis of a solution of potassium dichromate gave no deposit. Adding a little sulfuric acid made the deposition of a little chromium of very poor quality possible. Further additions of chromic sulfate and a good deal of sulfuric acid made it easier to deposit chromium, but the deposit was always of poor quality.

DEVELOPMENT OF THE FINK PROCESS

Dr. Colin G. Fink was a natural philosopher similar to Professor Wilder D. Bancroft at Cornell, but with more practical leanings, and he did not hesitate to tackle any project if it interested him. Along with this versatility he was also something of a business man and promoter, and generally had several students or others gainfully employed on research projects in his own laboratory. Born in New Jersey December 31, 1881,[113–116] Dr. Fink was the son of the founder of Lehn and Fink.

After graduating from Columbia University in 1903, Dr. Fink took up advanced studies in the Ostwald laboratories at the University of Leipzig, where he received his PhD degree in 1907. After inventing (a) duplicate tungsten for lamp filaments and (b) copper-clad lead-in wires to replace platinum in light bulbs, he left the employ of the General Electric Company in 1917 to become head of the new research laboratories of the Chile Exploration Company in New York City, and there developed an insoluble alloy anode, "Chilex," used in electrolytic copper recovery. In 1922 Dr. Fink was called to Columbia University as head of the Division of Electrochemistry. His long and productive career at this institution ended with his death on September 16, 1953.[117]

Charles H. Eldridge was born December 4, 1886, and died October 10, 1952.[118] He graduated from Ohio State University in 1909 with the degree of Mining Engineer. After various other connections, Eldridge worked as Dr. Fink's assistant for several years at the Chile Exploration Company laboratories. He then went to the U. S. Bureau of Mines in Pittsburgh, Pa. in 1922. Late in 1922, Dr. Fink persuaded Eldridge, who was then 35 years old, to join him again as his assistant at Columbia. The first project starting in January, 1923, was the restoration of ancient bronzes for the Metropolitan Museum of Art.[119] The method developed consisted in slowly reducing some of the patina back to metallic copper as cathode in 2 per cent caustic soda solution, with a very low current of 0.1 to 0.5 amperes for three or four days on the usual sized objects.

By the summer of 1923 the work with ancient bronzes was proceeding favorably and did not require all of Eldridge's time. Dr. Fink suggested that he take up work on chromium plating where Schwartz had left off, as Dr. Fink foresaw a big future for it. They decided to begin with electroforming small chromium objects, and trying to make them ductile by heat treatment. Both men had worked on the production of ductile tungsten, and were intensely interested in accomplishing the same result with chromium.

Eldridge actually started experimental work on chromium plating late in September 1923. He was successful in producing articles and samples of solid chromium, but after about two months work realized that more investigation was needed to determine the nature of the process, and to learn how to control it in order to get dependable results.

Accordingly, in January and February 1924, Eldridge tried varying the solution composition, and reached the conclusion that Schwartz's proportion of chromic acid to chromic sulfate had been too low, and that it should be increased. He accordingly arrived at 500 g/l chromic acid and 4 g/l chromic sulfate as his standard solution.

Professor Colin G. Fink (1881–1953) about 1920.

During March and April 1924, and earlier, Eldridge found that various grades of chromic acid gave varying results, and that some would not work. In April he optimistically obtained 300 lb of U.S.P. grade chromic acid in order to make up a larger tank, and was disappointed when it would not work. Analyses of a more expensive "Technical" chromic acid showed it to contain about 0.4 per cent of sulfate, whereas the U.S.P. grade chromic acid was found to have about 9 per cent sulfate in it. It should be realized that these analyses for sulfate were probably a little low, and more satisfactory methods of analysis were not developed until later.[120]

The supplier was called in and was willing to replace the chromic acid with a low sulfate grade after being informed of what was required. This resulted in a new grade of chromic acid, HPTP (high purity, tested purity), which dependably contained less than 0.1 per cent sulfate, and a solution of which would not give a chromium deposit without the further addition of catalyst radicals.

Things now began to take shape, and in the patent suits later, May 1924 was claimed as the date of the Fink invention. It should be realized that the discovery was not made at a certain exact time, that the controlling factor was the concentration of sulfate radical and its ratio or proportion to the chromic acid concentration. Rather, this knowledge slowly accumulated and was confirmed by experience, while Eldridge was busy plating samples for potential customers all over the country at the same time that he was investigating the matter. In January 1924 he had tried aluminum sulfate and sodium sulfate, and found that they worked the same as sulfuric acid or chromic sulfate.

So it was that Fink and Eldridge were satisfied about May 1924 that they could make up chromium plating baths and maintain them in continuous operation with optimum results. Dr. Fink enlisted the aid of capital, and with John T. Pratt formed the Chemical Treatment Company to do chromium plating work. The first patent application of Fink and Eldridge was filed August 26, 1924, Serial No. 734,193.

This application, later abandoned, was called an omnibus specification in that it included many matters in a single application; the bath composition, chromium plated golf clubs, printing plates, etc. A copy is not available, but it is understood that it was divided up and separate applications filed on chromium plated golf club heads[121] and printing plates.[122] Another later patent[123] was also based on it, and related to warming the object to the temperature of the bath before plating chromium on chromium at low current density.

One paragraph from the first patent application of August 26, 1924 has been frequently quoted to show the Fink idea of the sulfate radical as the important variable:

> "Thus the invention contemplates the electrodeposition of chromium from an electrolyte consisting primarily of a solution of chromic acid (CrO_3) and containing a well-defined limiting quantity of sulphuric acid or sulphate radical. The deleterious influence of an excess of sulphate in the electrolyte upon the electro-deposition of chromium has not, we believe, been heretofore recognized or appreciated and we are of the opinion that the failure in the past to produce consistently good results in chromium plating has been due to the lack of appreciation of the narrow limits within which the sulphuric acid (or sulphate radical) content of the electrolyte should be held."

From about May 1924 on, Eldridge was busy plating samples, and even articles for pay, on a small scale. Arrangements were completed and the Center street plant of the Chemical Treatment Company in New York City opened in January 1925. However, it was found necessary at the same time, early in 1925, to redetermine or determine more accurately and systematically, the limits of sulfate concentration in different baths and under different conditions, in order to control the plant solutions properly.

Charles H. Eldridge (1886–1952) at a United Chromium outing in Detroit in 1944.

The writer started to work for Dr. Fink at Columbia in June 1925, after C. H. Eldridge and V. C. Burr had left to work in the Center street plant. One of the writer's first assignments was to determine the bright plate range of typical chromium baths at different current densities and temperatures. These measurements were used to plot the curves for the Bright Plate patent, which was filed September 19, 1925, and issued April 28, 1931.[124] The area found was also published anonymously by the writer.[125]

The Bright Plate patent contained a good disclosure of the basic principles of chromium plating, the need to maintain a ratio of about 100 to 1 between chromic acid and sulfate ion, and the function of sulfate ions or other acid radicals as catalysts.

However, the inadequacies of the August 26, 1924 application became evident about this time (1925), and it was concluded best to file a new Bath Patent in Dr. Fink's name alone, in order to properly protect the invention. This was done on December 19, 1925, and the patent issued on April 20, 1926.[126]

The Fink patent was immediately recognized as of basic importance. It was reprinted in full in several magazines.[127] Now everyone knew, or had known all along, how to chromium plate. Judge Learned Hand expressed it very succinctly when he said:[128]

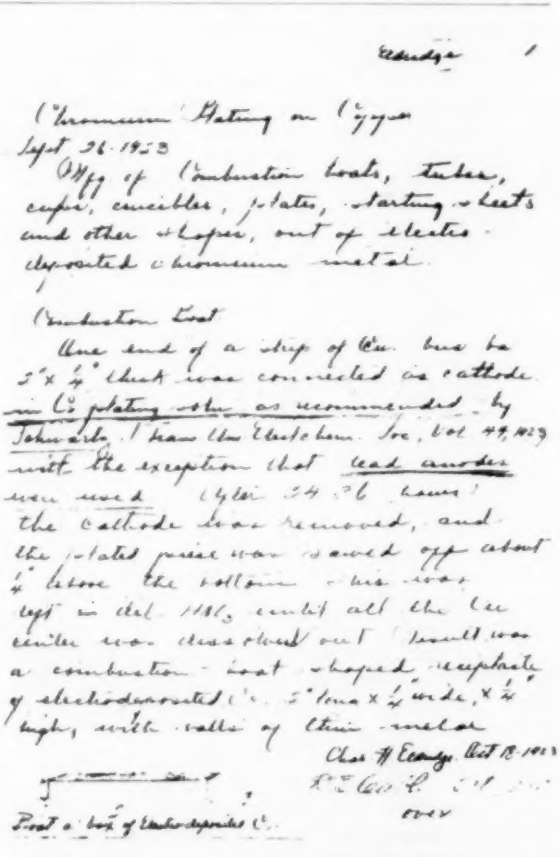
> "What Fink really did was to single out the acid radical as the catalyst, disregarding the substance which happened to contain it. As we shall show, nobody had thought of this before, and for that reason nobody had found a dependable process. . . . for the first time the art could turn out chromium plating with certainty."

In only a year or two, a new industry had been established. Simultaneously, on the urging of Mr. Pratt and others, thousands of dollars were spent in advertising chromium to the man on the street and to the housewife. Soon "chromium" became a household word for bright, non-tarnishing metal surfaces. The rapidity with which chromium came to be an accepted routine process is clearly evident from the annual reviews of the plating industry by Charles H. Proctor. At the end of 1923 Mr. Proctor said chromium plating ". . . is still a splendid dream."[129] At the end of 1924: "Chromium is still the missing link . . .".[130] After 1925: "Chromium . . . is still of great interest . . . but apparently it is not yet wholly out of the laboratory stage."[131] At the end of 1926: ". . . another great metal has appeared on the world's stage after lying dormant . . . chromium."[132] After 1927: "We must refer back to chromium both from the open as well as the patented basis. Splendid results are being obtained at present from both types of solutions."[133]

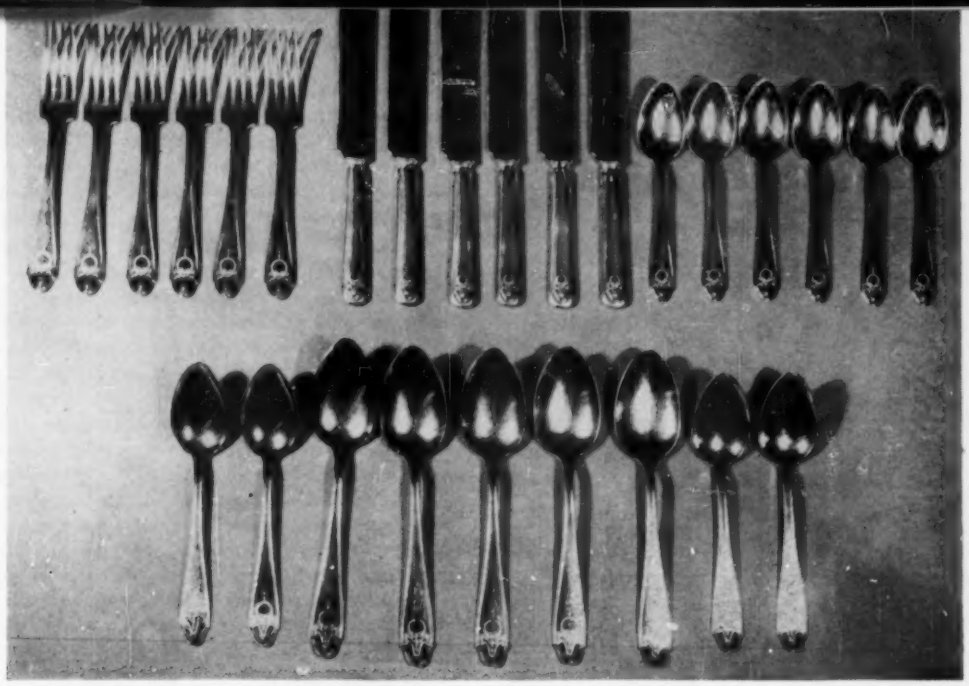
As is evident from the above quotations, widespread chromium plating started in 1926 according to Fink's teachings. The infant industry did not escape growing pains entirely, and it was frequently a struggle to get started. It was at first thought that chromium might replace nickel, but corrosion tests soon showed that when plating directly over steel, about three times as much chromium as nickel was required for equal corrosion resistance, probably due to the cracking of chromium deposits in addition to electrochemical differences. Consequently, the field for chromium plating soon broke up into two distinct types of application, decorative and hard chromium. The decorative deposits were applied in a thin layer (up to 0.00002 in.) over nickel or copper-nickel undercoats, for their appearance and non-tarnishing qualities. For the first few years, decorative chromium 0.0002 in. thick was used directly on brass articles; and some direct chromium plating in decorative applications is still being done on such basis metals, and also zinc, and nickel silver. It is standard for stainless steel. Heavier coatings applied directly to the basis metal became known as "hard chromium," and developed the most widely varied uses for their hardness and wear resistance, also resistance to heat and corrosion, and good frictional and other properties.

In the beginning much of the direct chromium plating was done with cold chromium plating baths which gave smooth, dull deposits with high current efficiency (up to 35 to 40 per cent), good throwing power, but relatively softer and less wear resistant coatings than deposits from warm baths. These dull deposits had to be buffed and polished, and even then seldom presented as bright or pleasing appearance as bright deposits from warm baths. The cost of buffing and polishing soon made such dull deposits uneconomic.

Nevertheless they continue to be used or proposed in Europe and other areas of lower labor costs. Thus Kutzelnigg made such a proposal in 1953[134] and 1955,[135] and Weiner reported on the effect of additions to the "D-Chromium Baths" (Direct Chromium Baths) in 1956.[136] Some of the additives were patented.[137] In the writer's experience there is frequently difficulty with the adhesion of chromium deposits from these cold chromium baths, and this is an important basic disadvantage.



Page 1 of Mr. Eldridge's notebook, September 26, 1923



Set of nickel silver and steel tableware hard chromium plated about 0.003 to 0.005 in. thick by the author in 1925 in Fink and Eldridge's first 15-gallon tank. This set is still in daily use.

Considerable credit should be given to the original job shops as well as the patentees for developing the technique of chromium plating. Chromium Corporation of America still operates a number of large plants. General Chromium Corporation of Detroit operated in this way for several years, and owned the patent application of Marvin J. Udy. Udy had worked on chromium deposition for Union Carbide Corporation beginning in 1922. When the Fink patent issued April 20, 1926, it was soon involved in an interference proceeding with the Udy application filed June 17, 1924.

With the formation of United Chromium Incorporated in 1927,[138] the Fink patent and the Udy patent application came under a single ownership, and it became necessary to dissolve the interference between them. It was concluded by patent counsel that the interference should be dissolved in favor of Fink. In the rather extensive litigation which came later,[139–145] the courts failed to agree on whether Fink or Udy was the first inventor. The last decision[146, 147] was that Udy had made the invention before Fink.

Unfortunately, Udy's work starting in 1922 was not published. He did publish three articles on his later chromium plating work,[148–150] and his recent book[151] included a chapter on his process of electrowinning chromium metal from chromic acid solutions. Udy died April 11, 1959, at 67.[152]

The 1920's were a time of great change and substantial improvement in electroplating processes. Hot, high-speed nickel solutions were introduced.[153] The control of acidity by means of *p*H measurements was established, and analytical control of plating baths generally became common practice during this period. The introduction of chromium plating contributed greatly to the acceleration of the introduction of improvements. Chromium placed a strain on nickel deposits and tended to cause them to peel. Better basis metal preparation became necessary in addition to the use of hot instead of cold nickel solutions.

The Madsenell process of ductile nickel plating was introduced at this time[154, 155] and made an important contribution. A feature of the Madsenell process was the treatment of the steel as anode in concentrated sulfuric acid immediately prior to nickel plating.[156, 157] This anodic treatment resulted in a well-nigh perfect bond, and was also found helpful in ensuring the best possible bond of hard chromium coatings on steel surfaces.

DEVELOPMENTS FROM FINK TO THE PRESENT

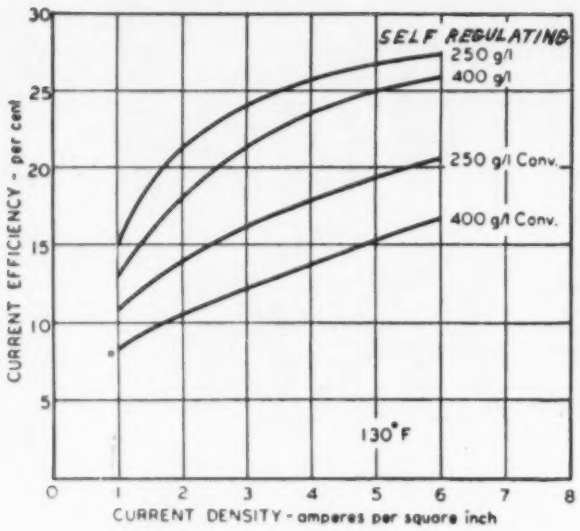
While it is often said that hard chromium plating was developed after decorative plating, the opposite is true. The first successful commercial applications were in the hard chromium plating field, and the widespread use of chromium as a decorative coating came a little later. For example, soot cleaner tubes were plated with a heavy deposit of chromium which did not need to be bright. The chromium was successful in this application because of its resistance to both wear and heat. Another early application was on printing plates for long runs. The hard chromium plating of tools, dies and gages was immediately successful. This included the salvaging of worn parts or parts machined undersize.

These early industrial applications of chromium deposits were admirably reviewed by Kolodney in 1943.[158] He describes them under three major headings:

1. Applications requiring hardness, wear resistance, and low coefficient of friction.
2. Applications requiring corrosion and oxidation resistance.
3. Applications requiring erosion resistance.

More recently, in 1948, Morisset[159] published a more detailed review in book form, including an annotated bibliography of over 1100 references. This was followed by an even more complete and well-rounded book in 1952,[160] which in turn was translated into English and appeared in amplified form in 1954.[161]

It was only natural that World War II expanded the usage of hard chromium plate tremendously. The ASTM adopted



Curves showing higher current efficiency of self-regulating baths compared to conventional solutions containing only chromic acid and sulfate in 100:1 ratio.[150]

a "Tentative Recommended Practice."[162] Aside from minor variations in the properties of different chromium deposits, the selection of the proper thickness of chromium plate for a given type of application was a problem in itself, and was well discussed by Coyle.[163] The hardness of the basis metal to back up and properly support the relatively thin chromium plate was equally important, and a number of specific figures were tabulated by Kolodney (reference 158, page 7).

Another rather remarkable war time development was the so-called "Porous Chromium" for improved oil retention and lubricating qualities, described by H. van der Horst,[164] T. G. Coyle[165] and Webersinn and Hyner.[166] This should not be confused with the porosity of chromium deposits as plated. Porous chromium plate is usually produced by plating to a thickness of 0.003 to 0.004 in. or more, and then etching the deposit or treating it anodically. This produces oil grooves or pockets in the surface, and also provides a surface which is readily ground or honed to size. Another type of "porous chromium" is produced by blasting the surface with coarse grit prior to plating, so that the finished ground or honed deposit has oil retaining pockets in the surface. These "porous chromium" deposits are widely used on aircraft cylinders and diesel engine cylinder liners.

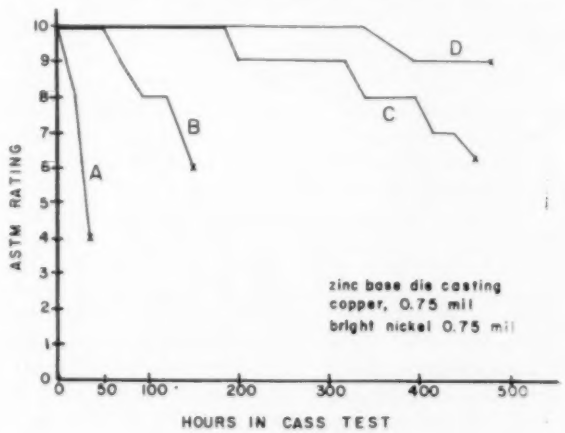
Beginning with Fink and Eash in 1926,[167] many efforts were made to barrel chromium plate small parts in bulk. These efforts have been described in an earlier paper,[168] and were surprisingly successful considering the complicated nature of the chromium plating process. Good results are being obtained in a number of plants, but careful attention is required to master the technique. Accurate control of the solution composition is necessary, but this has been simplified by the use of self-regulating baths.[169, 170] Recent patents relate to improvements in barrel construction.[171–173] Mahlstedt[174] described results with a larger automatic barrel of continuous feed design.

Although almost all commercial chromium plating was from sulfate catalyzed baths, considerable experimentation has been carried out over the years with baths catalyzed by silicofluoride in combination with sulfate, beginning with Fink and McLeese.[175] Much of this work was reviewed by Bilfinger[176–178] and also by Gebauer and Sommer.[179] These reviews and, particularly, Bilfinger's books lead to the conclusion that the mixed sulfate and silicofluoride catalyzed baths are impractical.

The problems associated with the difficulty of controlling the mixed sulfate and silicofluoride containing baths were overcome with the introduction of self-regulating baths late in 1949.[180] These baths are easily controlled, requiring little, if any, chemical analysis during normal commercial operation. They have many advantages over the straight sulfate catalyzed baths in that the deposit is brighter and/or harder under many conditions. During the plating process there is better activation (plating over somewhat passive nickel), and better ability to withstand current interruptions, which leads to ease in plating chromium on chromium. The outstanding advantages of these baths are the higher current efficiency and greater plating speed, together with improvement in covering power. These process advantages, as well as the ease of control of the self-regulating baths containing sulfate and silicofluoride, resulted in their being adopted widely in the United States and foreign countries.

Chromium electrodeposits have been most widely used for their decorative effect or for industrial applications requiring hard surfaces. It was widely considered that chromium did not contribute much to corrosion resistance of the plated metal. To obtain corrosion resistant decorative parts it was believed necessary to rely almost entirely on the effectiveness of the undercoating, usually copper followed by a nickel layer or nickel alone. During the past years a great deal of attention and study has been given to the problem of improving the corrosion resistance of chromium plated surfaces. Extensive work was carried out in attempting to improve the corrosion resistant properties of the chromium layer. Concomitantly many investigations were carried out to devise improved methods for accelerated corrosion testing, resulting in the now widely accepted Corrodkote and copper accelerated acetic acid salt spray (CASS) Tests.[181]

Progress in improving the corrosion resistance of chromium surfaced parts, for both decorative and industrial purposes, has been dramatic. In 1953 Dow and Stareck introduced an improved process for plating crack-free chromium which resulted in a corrosion resistant, dull, satin-finish type of de-



A. 0.01 mils chromium
B. 0.05 mils Duplex Chromium
C. 0.10 mils Duplex Chromium
D. 0.20 mils Duplex Chromium

Improvement in corrosion resistance due to Duplex Chromium.[196]

posit which had industrial application, and which could be buffed to a high luster for decorative purposes.[182–187] In 1957 Seyb, Johnson and Tulumello[188] announced the process for electroplating bright crack-free chromium up to 0.0001 to 0.00015 in. thick before any haziness or dulling started.

Subsequent studies in 1958 by Brown et al,[189] Sample,[190] and Safranek and Faust,[191] resulted in the recognition of the corrosion resistance of composite decorative coatings which could be gained by a thicker and/or crack-free chromium surface. Thicker chromium deposits were discussed by Seyb and Rowan in 1959,[192] and were found to increase the corrosion resistance of composite coatings far beyond what might be expected. During this period substantial improvements in corrosion resistance of composite coatings have also been achieved utilizing duplex nickel undercoats.[193, 194]

Very great improvements in achieving corrosion resistant chromium composites were made with the Duplex Chromium process announced by E. J. Seyb and co-workers in 1959.[195] Here a first layer of bright crack-free chromium plate was followed immediately by a second layer of highly cracked chromium. The very fine and numerous cracks in the second layer were non-injurious and gave substantial improvement in the corrosion resistance of the total deposit. Improvements of corrosion resistance in the order of 5 to 10 times have been achieved as shown in the accompanying chart.[196]

Thus one can see an accelerated rate of progress towards more corrosion resistant plated coatings to meet the needs of present conditions, with more cars being kept outdoors day and night and salt on the streets to melt snow and ice. Part of this need is being met with more adequate undercoatings. Simultaneously, it has been discovered that remarkable further improvement can be made with thicker chromium coatings. Space limitations do not permit a more extensive review at this time, but it is hoped that the above discussions will be helpful.

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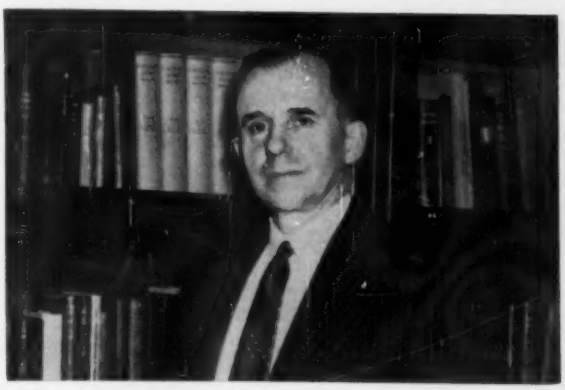
George Dubpernell is a graduate of the University of Michigan, 1924, where he was associated with the late Professor E. M. Baker. Dr. Dubpernell then worked and studied under Dr. Colin G. Fink at Columbia University and received the AM degree from that institution in 1927. Returning to Michigan he studied under Professor A. L. Ferguson and received the PhD degree in 1933 for work on overvoltage. His early experience with plating which began in 1919 included work on lead plating (Detroit Battery Company), zinc (Harris Zinc Process Company and Apollo Metal Works), copper and nickel (C. G. Spring & Bumper Company), and cadmium (The Udylite Corporation). He has been associated with the development of chromium plating since 1925, from 1933 on with United Chromium, Inc., now Metal and Thermit Corp. Dr. Dubpernell has authored many papers on electroplating and overvoltage. He is a member of the American Electroplaters' Society, American Chemical Society, Electrochemical Society, Institute of Metal Finishing, ASM and AIME.



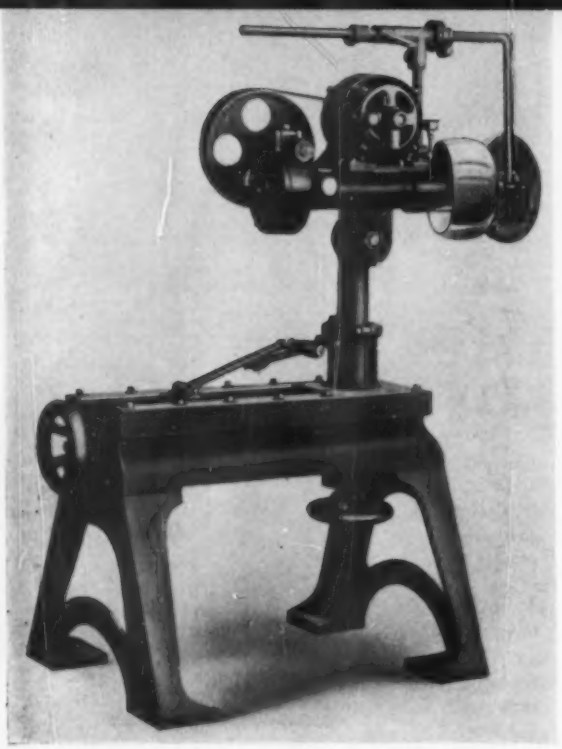


Fig. 1. One of the first semi-automatic buffing machines that was used for buffing the inside of brass automobile headlight reflectors in 1911.

FIFTY YEARS OF PROGRESS IN THE MECHANICAL FINISHING OF PRODUCTION PARTS

by GLEN CARLSON JR.*

*Manufacturing Process Engineer, Acme Manufacturing Company, Detroit 20, Michigan.

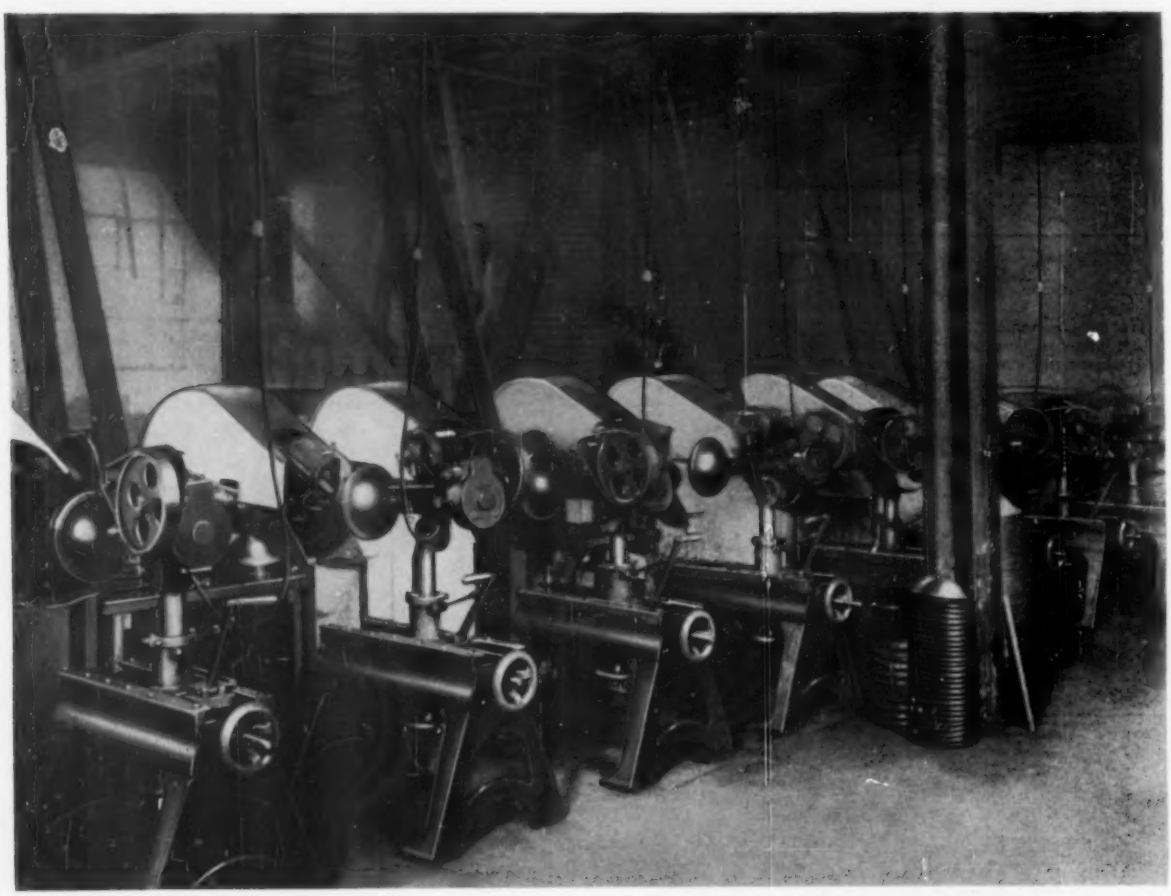


Fig. 2. A battery of semi-automatic buffing machines for headlight reflectors installed around 1911.

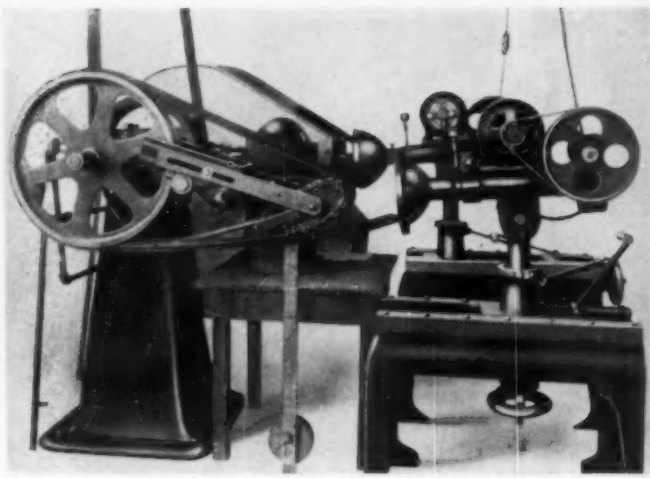


Fig. 3. A semi-automatic machine for polishing steel headlight reflectors in conjunction with a canvas and leather belt and emery material.

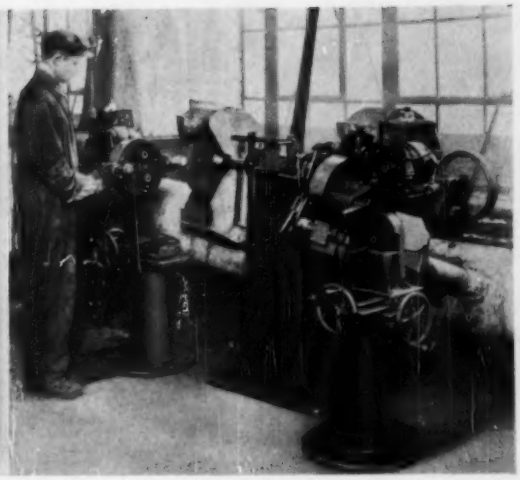


Fig. 4. A battery of two-spindle semi-automatic machines used to buff the Ford Model T hub caps.

URGENT REQUIREMENTS BY THE AUTOMOTIVE industry in 1910 for a machine to cut the costs of buffing brass headlamp reflectors by hand was the beginning of the application of mechanical techniques to the finishing of production parts. When the price of brass later rose from nine cents to forty-two cents a pound, the material for headlamp reflectors was changed to steel. This meant that polishing methods instead of buffing had to be applied by mechanical equipment.

Later when nickel and chromium plating techniques were introduced for appearance characteristics, more mechanical finishing equipment was required. It is a premise that the appearance of a plated surface is directly dependent upon the surface quality of the metal upon which it is deposited. This basic requirement has been one of the important reasons that the field for the mechanical finishing of parts has increased over the years.

In reviewing advances in the science of mechanical finishing it is amazing to note that automation techniques now being introduced as revolutionary in the machine tool and allied fields of heavy metal removal have been applied in the finishing of metals for decades.

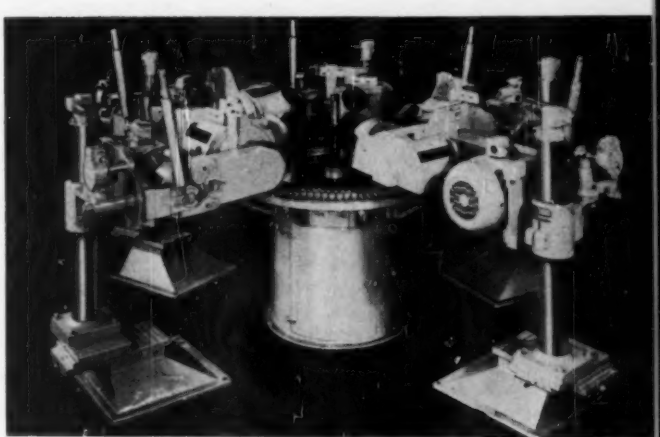


Fig. 5. A modern continuous rotary machine for high-production parts.

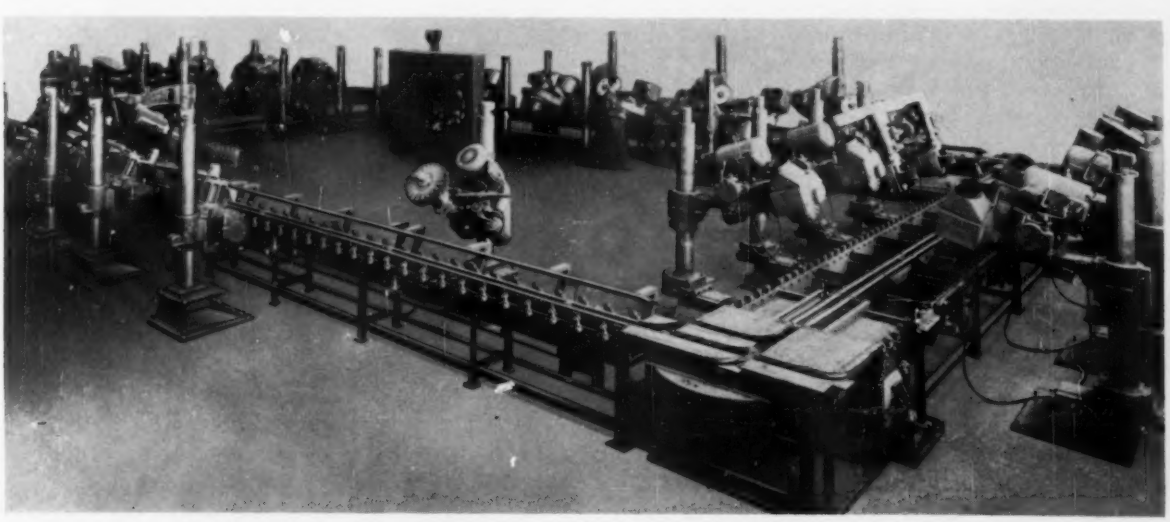


Fig. 6. A high production rectangular type straight-line machine for finishing automotive bumpers.

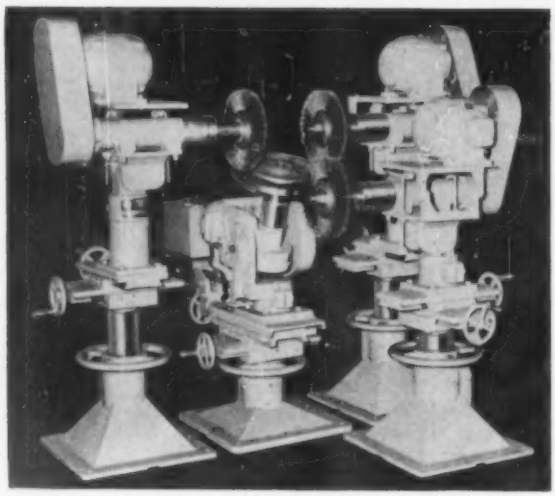


Fig. 7. A modern semi-automatic machine operating in conjunction with several adjustable lathes.

The mechanical finishing machines of 1960 are among the most sophisticated of the so-called automated production lines. They can provide grinding, polishing buffing and coloring, operations either individually or in sequence. Parts are moved, twisted, tipped, and turned under completely automatic controls while being polished and buffed. Today's machines are flexible. New designs for finishing flat parts, flat sheets and coil stock are helping industry to significantly cut its production costs.

These modern mechanical finishing machines are the result of fifty years of continual development by the metalworking companies and the suppliers of finishing machines and allied tools of the trade such as polishing wheels, buffs, abrasive belts and polishing compounds.

THE BEGINNING OF MECHANICAL FINISHING

One of the earliest mechanical finishing machines* was the brass headlamp reflector buffing machine, Fig. 1. This semi-automatic machine was first used in production in 1911 at a lamp company in Detroit. Later that year seven other headlamp manufacturers had applied the equipment in large departments like those shown in Fig. 2. When the brass headlamp was replaced by a steel one in 1914, the same machine was used in conjunction with a special belt polishing lathe, Fig. 3. The polishing belts were

*Built during 1910 by Acme Manufacturing Company.

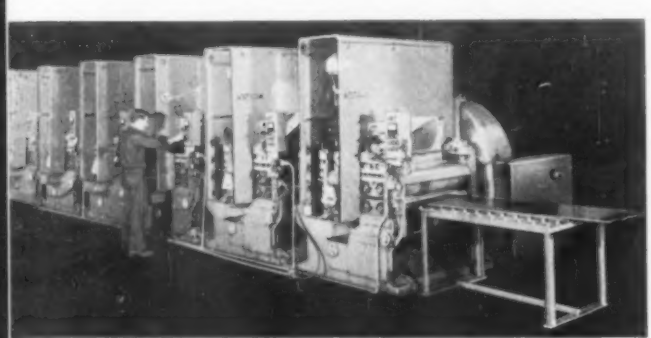


Fig. 8. A continuous line of abrasive belt finishing machines for polishing steel sheets.

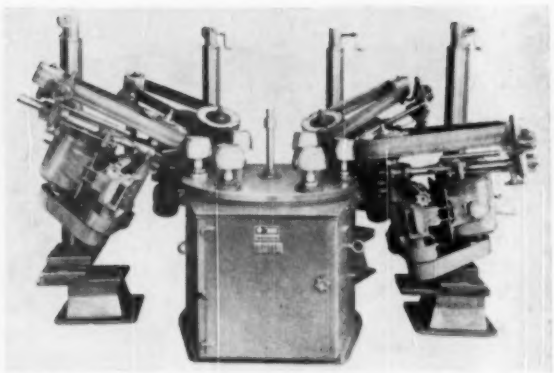


Fig. 9. A series of abrasive belt arms mounted on adjustable lathes around an indexing-type rotary machine.

endless double-thickness leather 1-½-in. wide by 10-ft long. Heavy canvas pieces were stapled on this belt. The polishing lathe had a belt tightening adjustment. An emery container was placed above the belt near the chuck on the machine. Loose emery dropped on this belt, carried into the reflector and then into a chute that directed it into a drawer. The emery was used over and over again.

The first two-spindle semi-automatic buffing machine Fig. 4, was used to buff the Ford Model T hub cap. Later versions of this machine had four and eight spindles. These machines were developed to meet higher production rates for small bezels, knobs, etc.

The automotive industry soon became one of many industries to make extensive use of mechanical finishing machines. Soon the headlight reflector machine was applied to the polishing of kerosene burner canopies and stove rings. The home appliance and builders hardware industries were other early users of mechanical finishing equipment.

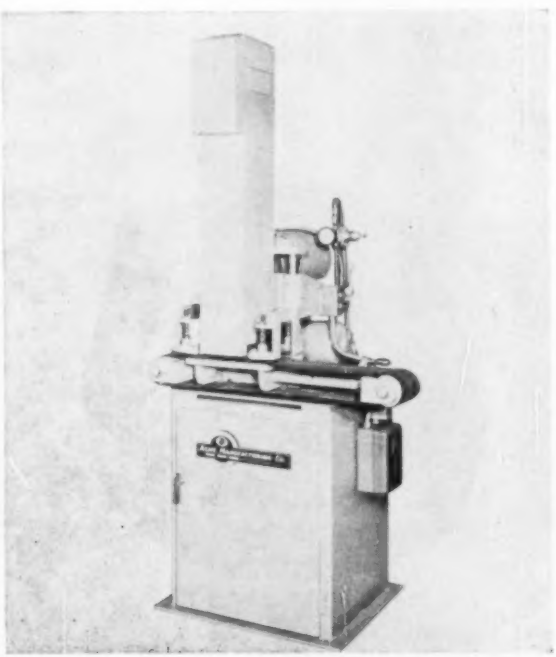


Fig. 10. A low-cost, high production, flat surface grinding and polishing machine.

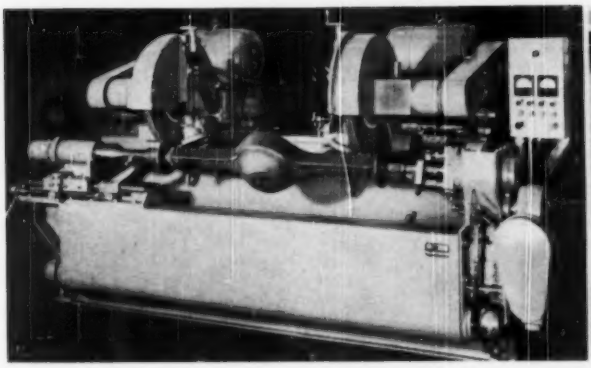


Fig. 11. A special machine for removing weld flash from a square-section axle housing.

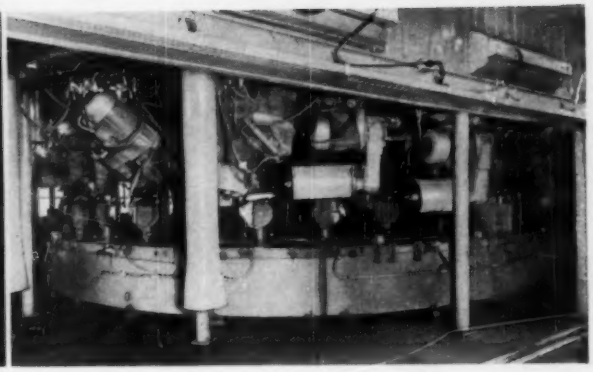


Fig. 12. A 31-ft diameter rotary-conveyor type machine that completely and automatically buffs bumper guards. It operates in a closed room.

REVOLUTION IN THE THIRTIES

Following the depression years several styling innovations took place in automobiles that had a lasting effect on the trends in the mechanical finishing field. Large wheel discs began to replace the former small hub cap. The bumper was changed from an item of utility to one of beauty that became a styling item. Both of these components became subject to annual changes.

With these design changes came increasing production volumes. As a result, entirely new concepts in mechanical finishing equipment had to be evolved. It suddenly took three semi-automatic machines to produce enough wheel discs. As a result, the rotary automatic was created in both indexing and continuous types. A typical modern continuous rotary machine for high production parts is shown in Fig. 5.

The stylized bumper required a straight line type of machine that would provide a succession of polishing and buffing operations. A modern bumper straight-line machine of the rectangular type is shown in Fig. 6.

Referring to Figs. 5 and 6 it can be seen that another piece of mechanical finishing equipment was developed simultaneously with the rotary and straight-line designs. This was the adjustable lathe. To polish and buff parts with curves and indentations requires accurate positioning of the wheel at various points along the process. Such lathes are made today in a variety of types to suit specific part requirements. A modern setup utilizing a semi-automatic machine in conjunction with several adjustable lathes is shown in Fig. 7.

THE TOOLING EVOLUTION

The tools of mechanical finishing have advanced along with the machine developments. In the early days of finishing, the life of a polishing wheel depended entirely on the skill of the operator. Today, automatic controls for wheel

Fig. 13. Typical parts finished on mechanical equipment in the 1920–1930 era.

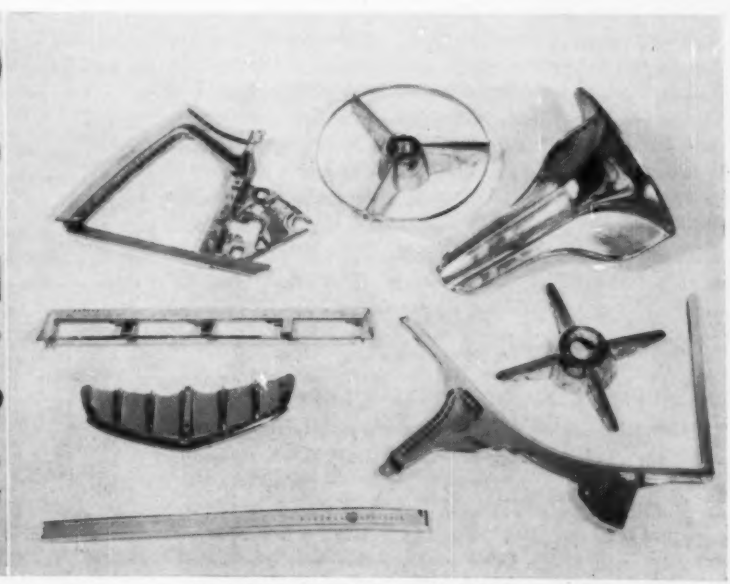


Fig. 14. Large modern die castings that are finished on mechanical equipment before plating.

Fig. 15. Small and medium-size modern die casting that are mechanically finished.

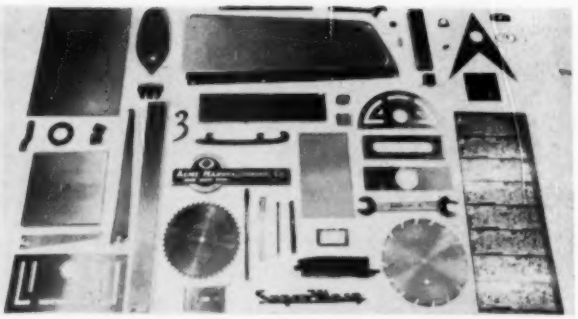


Fig. 16. Modern-day typical parts that are finished by flat grinding and polishing machines.

pressures, proper lubricant application and long-life polishing tools have taken much of this important cost factor out of the hands of the operator.

Buffing wheels have been improved considerably over the years with better materials and better ventilated designs that improve their useful life. Late in the 1930's another important tool of the finishing trade came into its own as a result of an automotive styling change. Automotive window frames had to have a weld mark removed. This was successfully accomplished by a combination of grinding and several abrasive belt operations. Even the old steel headlight polishing lathe made use of the principle of the abrasive belt. But it was the volume requirements by the automotive industry for abrasive belts on mechanical finishing machines that provided a great impetus to improvements in abrasive belt designs and broadened their applications. Today, the garnish molding which once required weld mark removal with abrasive belts is often a die casting or a stamping, but the abrasive belt is well established as one of the most important tools of the finishing trade.

ABRASIVE BELT FINISHING

One of the most active areas in the field of mechanical finishing today is that of abrasive belt polishing. This is effectively done to prepolish sheets of carbon steel before they are formed into bumpers. It is also being used by the steel industry to condition stainless steel stock. Sheet and plate can also be polished to standard finishes by continuous abrasive belt finishing lines such as that shown in Fig. 8. Another interesting application for abrasive belt finishing is the use of belt arms on rotary or straight-line machines, Fig. 9.

Another very active field for abrasive belt finishing machines is in the grinding and polishing of flat parts. This can be economically done on a variety of different types of machines in a fast, efficient operation. Figure 10 shows a typical flat surface grinding and polishing machine.

MODERN MECHANICAL FINISHING MACHINES

Today, the semi-automatic, rotary and straight-line machines are used by practically every type of metal manufacturing industry. Although it must be admitted that much of the impetus to these developments was made by the automotive industry, there soon followed a host of other industries such as the home appliance industry whose part and volume requirements approximated those of the automotive field.

One should not infer, however, that the field of mechanical finishing is one that only the automotive industry with high volume can utilize. For amost every product that has to be finished, there is undoubtedly a way to do it economically by mechanical means. If the various standardized types of equipment designs do not suit the requirement, a special machine like the one shown in Fig. 11 can be developed.

Today's finishing machines are getting consistently bigger and heavier, Fig. 12. They are made with more attention paid to universal features. Camming arrangements to provide more uniform buffing operations are being widely applied. A variety of speeds and feeds are now made available on modern equipment to enable maximum efficiency of finishing to be attained.

APPLYING MODERN FINISHING MACHINES

In Fig. 13 are shown a typical array of parts finished on mechanical equipment in the years from 1920 to 1930. Figures 14 and 15 show typical die cast parts that are finished on today's machines. Figure 16 shows some parts that have been finished by flat polishing techniques.

Another important factor that has contributed to more extensive use of mechanical finishing is the condition of the parts prior to finishing. Significant improvements in die casting and stamping process have made finishing operations less difficult. Modern materials are less porous, coated for process protection and more uniform than those of ten years ago.

There are still many applications for mechanical finishing that have not yet been exploited. These are being investigated and more new developments can be expected to provide cost-saving solutions.

Glen Carlson Jr. is the grandson of Gustave Alben Carlson who founded Acme Manufacturing Company on March 23, 1910 and is now living in retirement in Florida. His father, Glen Carlson Sr. is president of Acme Manufacturing Company.

Glen Jr. is an industrial engineering graduate of the University of Michigan and holds a Master's degree in business administration. Since graduation, he has been active in the company in both accounting and manufacturing processing activities.

ABRASIVE COMPOUNDS IN BARREL FINISHING

by ARTHUR S. KOHLER*

The article discusses the two primary types of deburring compounds, namely, with and without abrasive grains being present. It discusses the effects of size of particles and how the particles are reduced in size during the barrel finishing operation. Also discusses uniformity of size and toughness of the grains and the relative advantages and disadvantages of the use of various types of grain.

BARREL FINISHING OPERATORS know that the usual requirements for deburring include a "compound" (which is almost always a proprietary material), water, and in many cases, a medium. However, all too frequently it seems that the operator has very little idea of the actual functions of the materials used and the fact that the material used for JOB A may be entirely unsuited to JOB B. Nevertheless, with blind faith he adds the same compound to JOB B and is bitterly disappointed when the results obtained are not what he wants. As a result, he may decide that the "compound" is at fault and then proceeds to try other materials in the hope that eventually he will find the perfect solution to all of his problems.

Actually, there is no "ideal" compound since there is such a wide variety of problems encountered in the barrel finishing field. A compound should be considered as a 'tool' and not some miraculous thing that somehow knows what results we want and automatically produces the desired end result. There are available numerous compounds for deburring from a number of supply houses specializing in material for barrel finishing.

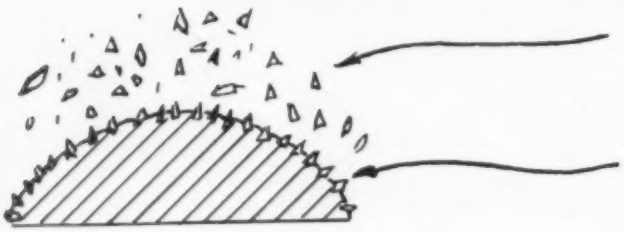
At the present time, barrel finishing is not a science and consequently much has to be determined by trial and error. The supply houses in many instances are constantly studying finishing problems and the present advanced state of this field is due in a large part to their efforts and development. While the suppliers will, in most cases, give technical help quite generously, it is the barrel finishing supervisor or foreman who has to determine the proper operating conditions for each type of job. An understanding of the types and properties of deburring compounds should be helpful in determining the material best suited to the job.

* Technical Director, Frederick Gumm Chemical Co. Inc., Kearny, New Jersey.

There are two basic types of deburring compound. TYPE 1 consists of various blends of chemicals which are free of abrasive grains. This type must be used with medium of an abrasive nature such as aluminum oxide, (either natural or manufactured), limestone, bonded abrasive chips, etc. It has no intrinsic cutting action in itself and is used to (a) prevent chemical attack (such as pitting or rusting) on the base metal, (b) prevent the medium becoming coated with metal grindings (which would hinder its cutting action) (c) produce a cleaner finish on the base metal by keeping the grit (from the medium) and grindings (from the metal) in suspension. The choice here is fairly simple since the same non-abrasive compound can be used widely on a given metal and for a wide variety of parts. Here the cutting action is controlled by the size, type and shape of the medium used. It is important that the material is suited to the metal being treated. For example, some of the compounds used for steel are strongly alkaline in action. Such materials would be unsuited for use with aluminum since the latter metal would be attacked and generate hydrogen gas which could easily build up sufficient pressure to cause a closed barrel to burst with explosive violence. Other metals which are easily attacked if improper compounds are used include zinc, magnesium, cast-iron, and the higher carbon steels in general. With this type of compound the principal information needed from the supplier is the recommended concentration and the fact that it is suited to the metal being processed. A TYPE 1 compound then exerts its influence on the deburring process in a *passive* way since it permits the medium to function at its best and prevents the metal from being attacked or unduly contaminated with soil.

TYPE 2 COMPOUNDS consist of an *abrasive* material blended with soluble chemicals similar to those used in TYPE 1 compounds and which function in the same way. This type of

FIG. 1. THE EFFECT OF ABRASIVE ON METAL SURFACES:



Slurry of abrasive in water

Abrasive particles become embedded in metal surface to form hard grinding surface

compound exerts a very decided, *active* influence on the deburring operation. Indeed, where such a compound is used with self-tumbling parts, i.e., where no medium is used, or where a metallic medium is used, it supplies all of the grinding action. Consequently, in these two cases, the deburring depends entirely on the compound employed. When a TYPE 2 COMPOUND is used with a hard non-metallic medium, it aids the medium in its cutting action.

The action which is most important in deburring is mainly one of grinding, wherein *small* particles of metal are ground from a surface or edge. Usually when the grindings are very fine, they appear to be black or very dark gray in color, and when these particles become embedded in the surface of a metal, they cause the metal to become dark gray or blackish in color. It is a well-known fact that where grinding of any kind occurs, it is necessary for an abrasive surface to slide past another surface, and there must be some pressure applied between the surfaces at the same time. In general, the coarser the grinding surface, and the greater the pressure between the two surfaces, the more metal is abraded from the surface being ground. Where the tumbling barrel contains only metal parts and metal medium, with an abrasive compound, the abrasive particles actually become embedded in the surface of the metal in both medium and work, and form surfaces very much like sandpaper or emery cloth. However, these embedded particles are self-renewing, since as fast as such particles are broken off or torn from the surface, fresh abrasive from the slurry of compound is quickly pressed into the surface again and grinding action continues indefinitely. Fig. I illustrates the rough surface formed on metallic slugs by the abrasive being embedded in the surface. Thus one must picture a vast number of small metal pieces coated with sheaths of sharp abrasive points. As these pieces slide and roll in the barrel, the more exposed corners and surfaces are gradually ground away.

When abrasive compounds are used with hard medium such as aluminum oxide, granite or ceramic, the medium is brittle and abrasive particles do not embed in the surface to any extent but rather scratch and gouge the surface of the medium. (See Fig. 2). As a result, even media that would tend to glaze can be kept sharpened and will have good grinding action. It is well known that a surface can only be scratched by a substance which is as hard as, or harder than, the surface itself. Consequently, for a deburring compound to be truly effective on a hard medium, it must be of sufficient hardness to be effective for roughening the surface of the medium. Obviously, if an abrasive is softer than the medium used, it cannot roughen the surface of the medium, and consequently, is of little real value as a deburring compound. Here the relative hardness of the abrasive compound and the medium must be considered.

In order to understand why there are so many varieties of compounds available today, it would be well to look into the properties of abrasives in general. Such properties include hardness, toughness and size. In general, these three items determine the field of usefulness of an abrasive material. The hardest of all substances is, of course, the diamond which is not practical for barrel operation from a cost standpoint. Cheaper and more practical compounds include carbides, aluminum oxides (both natural and synthetic), lime, silica of various types and garnet. Just which of these is selected for a deburring operation depends upon the job to be done and also on cost considerations. It is reasonable to expect that two materials can be found which will produce the same ultimate job, although one might cost considerably more than the other. However, it is possible that the more expensive material can do the job in half the time of the other one. If time is important, perhaps the more expensive compound might be cheapest in practice. This is something that has to be determined by local conditions.

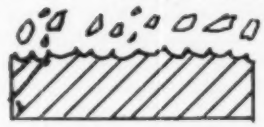
FIG. 2. THE EFFECT OF ABRASIVE WITH STONE OR CERAMIC MEDIUM:

Without abrasive added

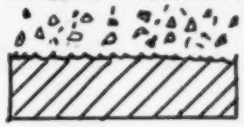
With Abrasive added

Surface is roughened by scratching of abrasive and medium has a "sharper" cutting action.

FIG. 3. "MATTE-NESS" OF A SURFACE DURING PROLONGED GRINDING OPERATIONS:



Initial Action
Abrasive-coarse



As action progresses abrasive becomes finer and surface is less matte.

Ultimately, abrasive becomes quite fine and surface tends to be polished

Before considering the requirements of abrasive compounds, the following often overlooked fact is of interest. The tumbling barrel has been used for many years as a grinding mill in the paint and chemical industries. Generally such mills use flint pebbles or iron balls and particles of pigment, etc. which can be ground down to micron size or less. In the metal finishing field the abrasives are also ground finer and finer as the action continues. The result is that an abrasive has its maximum coarseness at the start and as action progresses, the particles become smaller and smaller. The rate of deburring (within limits) is faster with larger abrasive, and slower with fine; this is obvious when we compare tumbling to the action of belt grinding. Following this analogy a step further, it is obvious that a finer abrasive should produce a finer and smoother surface. This we find in fact in our barrel work.

In the first hour of operation, the surface is quite matte and the cutting action is rapid, see Fig. 3. During subsequent hours, the cutting slows and the surface becomes less matte. If the action is continued long enough, it is possible for the same charge of compound to start polishing the surface. Such action may be desirable in some instances, and a nuisance in others. The obvious question is—How can the breaking down of the particle sizes be controlled?

This process of grinding of the abrasive grains depends upon crushing of the grains between the pieces of medium or work and also on particles of abrasive wearing each other down. Just how fast this process occurs depends on how large and hard the medium is and also on the toughness or resistance to grinding of the abrasive itself. In general, the larger the size and harder the medium used, the more rapidly the particles of abrasive are broken down. Thus, an abrasive might be still quite effective for cutting after eight hours when used with a quarter-inch sized medium, whereas the same abrasive might lose most of its effectiveness in a few hours when used with a three-quarter or one inch medium. The hardness of the medium also affects the rate of grinding since a harder medium tends to crush the grains more rapidly than a softer medium.

Fortunately, there is a difference in the *toughness* (or resistance to grinding) of various abrasives, thus some might become very fine in an hour or two, whereas others under heavy grindin$_g$ conditions may still be effective up to 15 or 20 hours. We now have one criterion for chosing a compound.

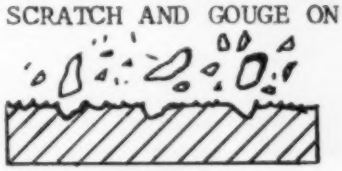
Where a long rolling operation is obviously required, as e.g., on sand castings, rough forgings, etc., ask for a long-lasting deburring compound. On the other hand, for light deburring, particularly on the softer metals, such as brass or aluminum, a short lived compound might be much better, since such a material will deburr rapidly in the first hour or two and produce a smoother or less matte surface in 3 or 4 hours.

Even the toughest abrasive compounds wear down appreciably in 12–20 hours (depending on operating conditions) and where a longer roll is required for heavy deburring, for example, when smoothing rough sand castings or forgings, it is best to add a second charge of compound after about 15 hours. Due to the fact that in this time there is a heavy accumulation of grindings in the barrel which tend to hinder deburring, it is advisable to flush out this sludge before adding a fresh charge of compound.

Very fine polishing-type compounds do not lose their effectiveness as rapidly as the coarser materials and are still effective up to 30–40 hours of tumbling.

The *hardness* of the cutting grains are of some importance

FIG. 4. EFFECT OF EVEN A SMALL PERCENT OF COARSE GRAINS WHICH SCRATCH AND GOUGE ON OTHERWISE LIGHT MATTE SURFACE:



Bulk of grains are fine, but few coarse ones make deep pits.

After burnishing, the deep pits remain and cause poor depth of color.

since some of the extremely hard alloys are completely resistant to the usual deburring compounds. However, the deburring abrasives in common use today are sufficiently hard for cutting the more commonly fabricated metals such as mild steel, brass, magnesium, etc. Since deburring is slower with the harder steels and alloys, it is generally found desirable to use the tougher and longer-lasting abrasive compounds for these materials.

The *size* of the grains of abrasive also is of great importance. This directly affects the coarseness of the finish on the surface, which in turn affects the appearance of the finished article. Naturally, the coarser grains produce a coarser surface which is often preferred where the parts are to be coated with paint since such a surface has considerable "tooth" for anchoring paint. It also affects the appearance of the painted coating producing a dull finish unless a heavy coating is used. Where a thin decorative paint coating is to be used, a finer matte finish would be more desirable. On parts that are to be subsequently plated, a rough surface on the base metal tends to produce a dull finish rather than a smooth bright finish. While this may not be important in some cases, such as zinc or copper plating, it would be undesirable where a decorative finish is desired.

Where a moderate matte finish is desired, it is necessary to avoid the use of compounds containing excessively coarse particles, and this is particularly true when the work is to be subsequently finished with a polishing compound or ball burnished. Even small amounts of coarse particles in the deburring compound will produce sufficient pits and scratches so that the surface after burnishing will have a "flat" appearance without depth of color.* It is surprising but even one per cent of coarse grit in a compound can have a very harmful effect on what would otherwise be an acceptable finish Fig. 4.

Abrasives after crushing and grinding are usually graded into sizes by passing the material through a series of screens. In the finer sizes, since the mesh is so small, the sifting action becomes quite slow and also expensive. Also screens are easily damaged and small amounts of contamination from larger sizes is quite common. Often commercial grades have to be specially processed to remove these oversize grains. This is an expensive operation and naturally results in a more expensive compound. Fortunately, in many cases, the more carefully graded abrasives are not needed and cheaper materials are completely satisfactory.

Where fast deburring is desired without unduly matting the surface, a moderately fine, tough abrasive free of excessively coarse particles will be found satisfactory. Sometimes blends of several types of abrasives will be found most economical to use.

At the lower extreme of sizes where the abrasive approaches sizes of a few microns, the deburring action is relatively gentle and the surface of the work is polished instead of being roughened. Nevertheless, despite the relatively fine cutting action, there is still reasonable stock removal. Such a fine compound is most successful on hardened steels where mirror finishes are readily produced. Small chips of hard abrasive must be avoided and most commonly soft metallic media such as zinc slugs are to be preferred as carriers for the abrasive.

As was pointed out earlier in this article, abrasive of any kind embeds itself into the surface of the metal parts and it is important that such deposits be removed after deburring before further processing. Ordinary rinsing is of little help in removing such impacted material since it is strongly adherent to the surface. If such residue is not removed, it will pass through the usual cleaning cycles and produce dull, poorly adherent plating. If the parts are to be burnished, a shiny surface may be obtained, but such a surface may be dark and completely lacking in "depth of color". If the parts are to be drilled, formed or otherwise machined, it will be found that such residues rapidly score dies, dull drills and other cutting tools. The only satisfactory method of removing such impacted residue is by the process called tumble flushing. This consists in filling the barrel with water and allow the water to discharge from the barrel as it rolls, using a flush-door (perforated door) in place of the regular cover. This operation should be repeated 3–4 times. As the pieces rub together, the grains are mechanically rubbed off the surface and suspended in the water. While a few may redeposit during this treatment, the great bulk of the grains are suspended in the clean water and drain from the barrel. When properly carried out, such tumble flushing will remove well over 99 per cent of such residues. This operation should be carried out thoroughly without any short cuts.

As has been shown non-abrasive deburring compounds are adjuncts to aid the abrasive medium function at its best. However, the abrasive type compound is most important in determining the speed and the degree of cutting and to a large extent the final surface finish of the work. This latter type of compound thus can produce finishes from a coarse dull matte of about 30–35 microinches down to a fine polished surface of 1 microinch or even less. The abrasive compounds also vary in type, size and degree of grading. Such abrasive compounds are constantly being developed, modified and studied and are available from reputable supply houses.

This article has endeavored to create a better understanding of some of the problems encountered in designing deburring compounds and thus give the operator a better understanding of what to look for in a compound. While Gertrude Stein may think "A rose is a rose is a rose", there are deburring compounds of all varieties and properties.

Arthur S. Kohler is technical director of the Frederick Gumm Chemical Company with which company he has been associated for the past 16 years. Before joining the company, he was assistant Professor of Chemistry at the Newark College of Engineering, where he taught physical chemist y and unit operations. He is a graduate of the Polytechnic Institute of Brooklyn and Columbia University. He has lectured before many branches of the American Electroplaters' Society, and has written a number of papers on barrel finishing in both American and British publications. Mr. Kohler is author of the section on "Barrel Finishing" in the "Metal Finishing Guide Book." In 1954 he won the R. S. Leather Award (AES) for an article on Ball Burnishing.

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* For a discussion of the theory of "depth of color" see "Some Considerations of Importance in Ball Burnishing"—A. S. Kohler, Proc AES 1954, p. 155 or PLATING, September 1954.

AN OUTLINE OF THE CHEMISTRY INVOLVED IN THE PROCESS OF CATALYTIC NICKEL DEPOSITION FROM AQUEOUS SOLUTION

(PART IV)

by G. GUTZEIT*

Temperature

As originally shown by Brenner et al,[1] the rate of deposition increases rapidly with temperature (it is, in fact, an exponential function of temperature). A decrease of 10C between 100° and 90° corresponds to a drop in plating rate of 52.5 per cent. This relationship is illustrated in Fig. 12. On the other hand, practically no nickel reduction will occur at temperatures below 70C in acid solution (*p*H 4–5). Therefore, the operating temperature should be preferably at 95C or above, provided local overheating—which would result in bath decomposition—is carefully avoided.

In the design of a continuous industrial chemical nickel plating system according to the KANIGEN® process, advantage is taken of bath stability at low temperature for the performance of steps (pumping, filtration, regeneration) which inherently would tend to favor spontaneous chemical reduction. The solution is cooled to 70–80C as it leaves the plating tanks, and is heated again to 95C or above before it re-enters the vessels.[3, 31]

Nickel and Hypophosphite Ion Concentration

One of Brenner's important teachings was to define the general range of concentration of nickel cations and hypophosphite anions in the bath allowing the catalytic reaction to proceed on the surface of the immersed solid body at temperatures of 90C and above (*p*H 4–6) without simultaneous chemical random reduction within the solution. As already mentioned, this initial range in acid solution was stated to be between 3 and 100 g/l (0.051–1.7 M) for Ni^{++} and from 10 to 100 g/l (0.114–1.136 M) of $Na[H_2PO_2]$. However, further investigation of these broad conditions by Gutzeit and Krieg[21] revealed that, in order to achieve optimum quality of coating and highest rate of depositions, a more narrowly limited absolute concentration of hypophosphite, well-defined molar ratios of nickel/hypophosphite, and close control of *p*H are required.

With the purpose of avoiding results which could lead to ambiguous interpretations, this study utilized solutions containing no complexing (chelating) additives, but only the basic ingredients, i.e., Ni^{++} (as nickel chloride), $[H_2PO_2]^-$ (as sodium hypophosphite), and relatively low concentrations of acetic acid-sodium acetate as a convenient buffer system (approximate *p*H of maximum buffer capacity = 4.6 ± 1). An extensive number of experiments showed that highest rates of deposition and optimum plating quality were obtained—other factors (temp 99C; *p*H 4.5–5.6) being kept constant—when the following conditions† were fulfilled:

1. The optimum absolute concentration of hypophosphite ions‡ should be within the range of 0.15 to 0.35 M—the preferred concentration being 0.220–0.230 M.
2. The optimum ratio between the nickel ions‡ and the hypophosphite ions‡ $Ni^{++}/[H_2PO_2]^-$ expressed as a decimal fraction in terms of molar concentration should be within the range of 0.25 and 0.60—the preferred value being 0.30–0.45 M.
3. The minimum absolute concentration of the buffer anions (acetate) should be equivalent at least to two carboxyl groups per ion of nickel that can be deposited. For instance, if a hypophosphite ion concentration of 0.225 M is selected, the required concentration of acetate ions should be approximately 0.120 M.

Fig. 13 shows, in graphic form, data obtained by varying the hypophosphite ion concentration.

Fig. 14 shows the effect of increasing the ratio of $Ni^{++}/[H_2PO_2]$ from low (Brenner) to optimum (0.224 M) hypophosphite concentration.

Fig. 15 illustrates the results obtained at two different *p*H values.

Hydrogen Ion Concentration (*p*H)

The effect of *p*H variations on the basic reaction and its useful product have already been discussed. Nickel reduction is favored by a relatively low hydrogen ion concentration, while phosphorus deposition is enhanced by a high hydrogen ion concentration. (Ref. Equations VII to IX and Table VII).

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†Patented in the United States and abroad.

‡The term "ion" as employed here includes the total quantity of element or radical dissolved in the bath, in other words, 100 per cent dissociation of the compounds is assumed

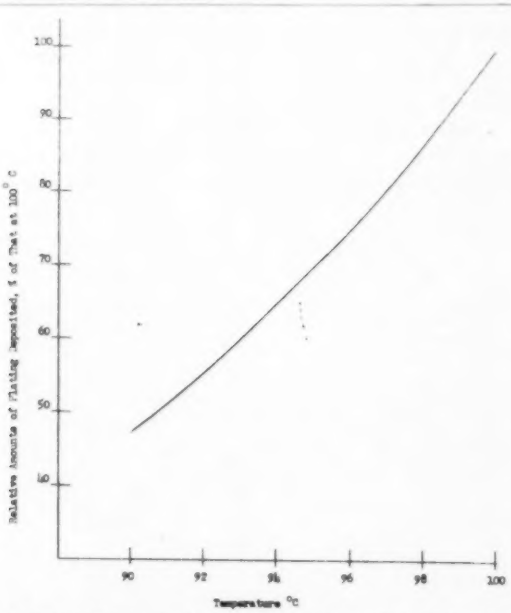


Fig. 12. Relative rate of deposition (in per cent of maximum) as a function of temperature.

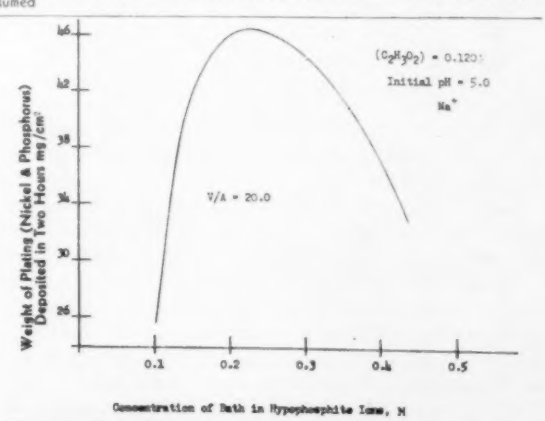


Fig. 13. Rate of deposition from acetate bath as a function of hypophosphite concentration.

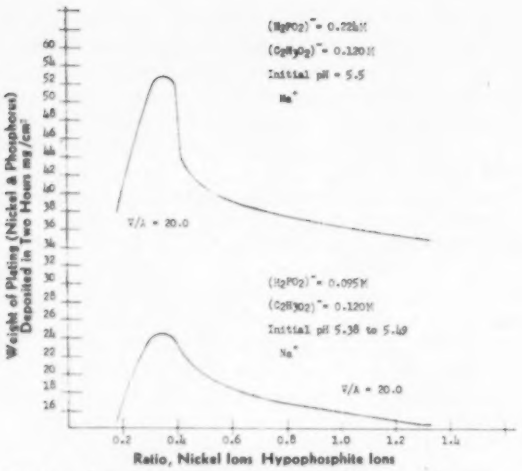


Fig. 14. Rate of deposition from acetate bath as a function of $Ni^{++}/[H_2PO_2]^-$ molar ratio.

In other words, the plating rate increases with rising *p*H while the phosphorus content of the coating decreases. On the other hand, solution stability declines under these same conditions, because an excess of hydroxyl ions will shift hypophosphite oxidation from a catalytic to a homogeneous reaction. (Ref. Equations III and IV). On the basis of the facts outlined above, it would appear that an acid plating bath should be operated slightly below the neutral point (5.5 to 6.5). Actually—even disregarding the matter of stability—there are two important factors to be considered in the choice of the preferable hydrogen ion concentration range.

a) The only stable anion produced by the basic reaction (Ref. Equations I, VII and VIII) is orthophosphite, which forms a relatively insoluble nickel salt in the near-neutral region.* The solubility increases with increasing hydrogen ion concentration. Table XVI indicates solubilities of nickel phosphite at 25C determined by analysis of saturated solutions at increasing *p*H values. (Nickel phosphite has a reverse solubility curve, and, therefore, is substantially more soluble at room temperature than at 95C.)

TABLE XVI
SOLUBILITY OF NICKEL PHOSPHITE AS A FUNCTION OF *p*H

*p*H	Moles/liter Ni^{++}	Mole ratio of $[H_2PO_3]^-/H[H_2PO_3]^-$
3.0	0.160	0.329
4.0	0.141	0.280
5.0	0.089	0.203
6.0	0.0206	0.0274
7.0	0.0153	0.0163

As can be seen, the dihydrogen phosphite is formed at the lower *p*H values, while the monohydrogen phosphite predominates at higher *p*H.

Under plating conditions (*p*H = 4.6; temperature = 98C), nickel phosphite solubility is about 0.03 to 0.07 moles/liter, depending on the presence and concentration of other ions.

Because the formation of a precipitate within the bath will cause roughness of the deposit (and eventually decomposition of the plating solution), it is advantageous to select a *p*H value which represents the best compromise between greatest nickel orthophosphite solubility, maximum deposition rate of nickel and relatively high bath stability. Investigations have established that this *p*H is 4.6 ± 0.1. These findings were later confirmed by de Minjer and Brenner.[22]

b) Another factor which is strongly in favor of a relatively low plating solution *p*H (<5.0) is the adhesion of the coating, which decreases markedly as the *p*H increases (particularly on ferrous substrata). While absolute data are not available for the whole *p*H range from 4.3 to 6.5, comparative tests give figures (on steel) from about 60,000 psi (at *p*H 4.4) to less than 30,000 psi (at *p*H 6.0).

It should be pointed out that, in batch operations(and in ordinary laboratory tests used to define plating conditions), the initial *p*H only is an independent variable. During the reaction, the hydrogen ion concentration increases by 2 moles for each mole of nickel deposited, and the rate decreases accordingly. Therefore, the rate data obtained can be quite ambiguous, even at a large Volume/Area ratio, unless a high concentration of a suitable buffer system is present (which involves other drawbacks in production), and unless the period of use (or the duration of each experiment) is relatively short. In a continuous recirculating industrial system, on the other hand, *p*H value of the solution (as well as its composition) is maintained constant (preferably through automatic control) by addition of reagents supplying OH^- ions, so that the coating conditions remain invariant.[23]

Complexing and Chelating Agents

When performing electroless nickel plating in an alkaline bath, the presence of a compound forming water soluble nickel complexes is obviously necessary in order to prevent precipitation of nickel hydroxide. Thus, Brenner's alkaline bath contains ammonia and ammonium salts for that very purpose.

In a moderately acid chemical coating solution (which lends itself to much better control), presence of a complexing agent is also indispensable both from a technical and economic point of view in order to retard precipitation of nickel orthophosphite. It has been pointed out earlier (Part I) that the "hypophosphite utilization" is about 33 per cent; in other words that approximately 3 moles of hypophosphite are oxidized to orthophosphite for each mole of nickel ion reduced to the metal. Consequently, the orthophosphite concentration increases rapidly as plating proceeds, and will soon reach the average solubility threshold of 0.05 M of nickel phosphite (at *p*H 4.6 and 95–98C). Above this level, precipitation occurs, with concurrent deterioration of deposit quality and bath stability. By adding a sufficient amount of a chemical able to "tie up" the nickel ions as a soluble complex, this occurrence can be prevented, or at least considerably retarded.

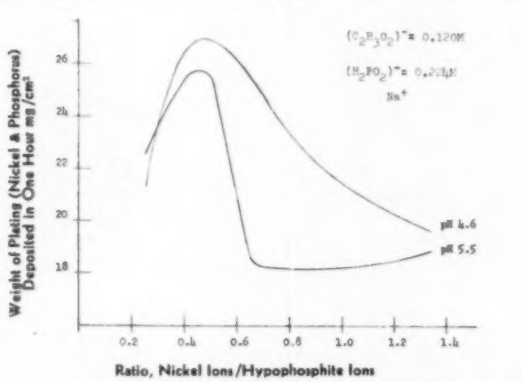


Fig. 15. Rate of deposition from acetate bath as a function of $Ni^{++}/[H_2PO_2]^-$ molar ratio at two different pH values.

*Solubility of $NiHPO_3 \cdot 7H_2O$ at 50C is 0.2875 g/100 cm³ H_2O. Solubility of $Ni(H_2PO_3)_2 \cdot 6H_2O$ at 50C is 37.6480 g/100 cm³ H_2O.

TABLE XVII

DEPOSITION RATE AS A FUNCTION OF NATURE AND CONCENTRATION OF HYDROXY-CARBOXYLIC ACID ANIONS

Hydroxycarboxylic Anion	Glycollic	Malic		Tartaric	Citric			Lactic
Concentration M	0.30	0.15	0.30	0.30	0.10	0.20	0.30	0.30
Plating Rate R × 10^4 g/cm²/min.	2.51	2.35	1.79	1.53	1.55	0.63	0.16	3.53

Organic carboxyl compounds containing one or several additional functional groups acting as coordination centers ($^-NH_2$, ^-OH, C=O, etc.), and thus capable of forming nickel chelates, are particularly valuable additives for this purpose, because they also represent buffer systems in the presence of their alkali salts. Moreover, they enhance bath stability to a certain extent by decreasing the concentration of free nickel ions available for random reduction. It is obvious that the selection of such a chelating agent should be guided by a proper understanding of its function. The "ideal requirements" would be as follows:

1. The nickel chelate should be water soluble.*
2. The nickel chelate should be reactive; in other words, the nickel ions in the ring compound should be weakly crystal-field stabilized.
3. The effective buffering range of the substituted carboxylic acid in the presence of its sodium salt should be within the desirable *p*H area.
4. Cost of the chelating agent should not be excessive, and it should be commercially available.

There is only a very small number of organic compounds which fulfill all four conditions. One compromise adopted by Brenner and others has been addition to the bath of such organic acids as glycollic and citric in less than the stoichiometric amount required for complete complexing of the nickel ions. Even in that case, the deposition rate of nickel-phosphorus is usually slowed down disproportionately to the concentration of the substituted carboxylic compound. Moreover, nickel phosphite precipitation is thereby not sufficiently retarded, so that bath life is short. Some chelating agents, such as malic or tartaric anions, which would be, otherwise, quite suitable (because they fairly fulfill conditions 1, 3 and 4), cannot be used even at low concentrations, because their stability is so great that deposition barely takes place within a practical period.[2] While this last drawback can be overcome by the addition of "exaltants" (Ref. next paragraph), it is, of course, more desirable to select a chemical additive which comes as close as possible to the "ideal requirements."

Lactates[14] have been found particularly suitable. As a matter of fact, they have one additional advantage, which is of great practical value. Within a definite concentration range, they increase substantially the deposition rate of the nickel coating. De Minjer and Brenner[22] later observed that the lactic bath would be most desirable, but is particularly unstable. This latter fact was not confirmed in General American's laboratories or production plants, probably because all coating solutions also contain effective stabilizers (vide infra) to prevent random reduction of nickel ions

It was found, as could be predicted, that the phosphite tolerance (threshold of nickel phosphite precipitation) is a simple function of lactate concentration; while, quite unexpectedly, the plating rate goes through a maximum when the Ni^{++}/lactate ratio is about 1:3 (which is not the case with most other aliphatic hydroxycarboxylic additives). Tables XVII, XVIII and XIX and Figs. 16 and 17 give some illustrative data.

The main purpose of the chelating agent being prevention of nickel phosphite precipitation, the amount to be added should be at least sufficient to complex all the nickel ions present in the bath, and to allow a phosphite tolerance of 1.0 M or better.

While, strictly from the point of view of deposition rate, a

*For structural characters favoring water solubility of chelates, see G. Gutzeit—Am. Inst. Mining Met. Engrs., Mining Technology, **10**, No. 6, Tech. Pub. No. 2077 (1946)—Appendix.

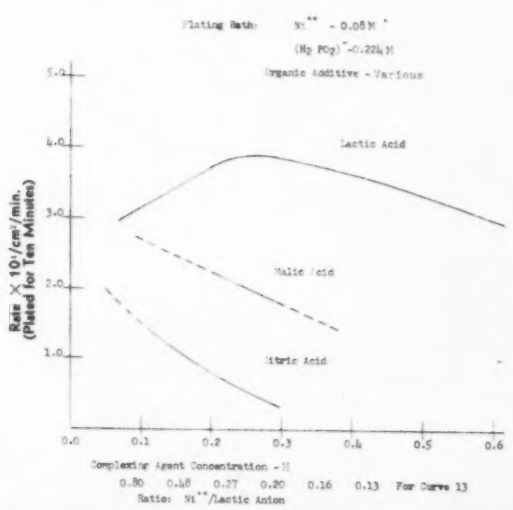

Plating Bath: Ni** - 0.08 M
(H2 PO2)- 0.22 M
Organic Additive - Various
Lactic Acid
Malic Acid
Citric Acid
Rate X 10⁴/cm²/min. (Plated for Ten Minutes)
Complexing Agent Concentration - M
0.30 0.15 0.27 0.20 0.16 0.13 For Curve 13
Ratio: Ni**/Lactic Anion

Fig. 16. Rate of deposition as a function of chelating agents (hydroxy-carboxylic anions) concentration.

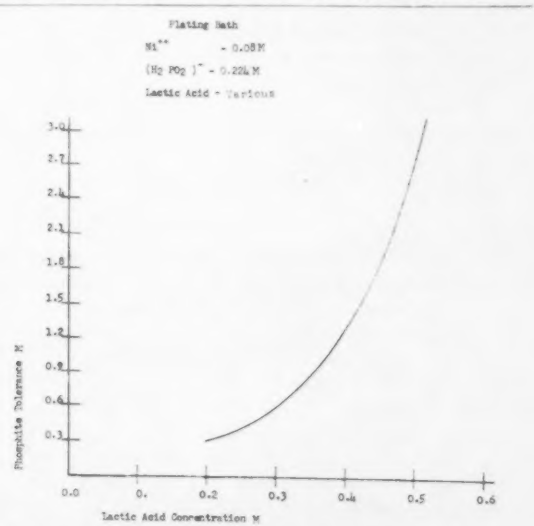


Fig. 17. Phosphite tolerance of plating bath as a function of lactate concentration.

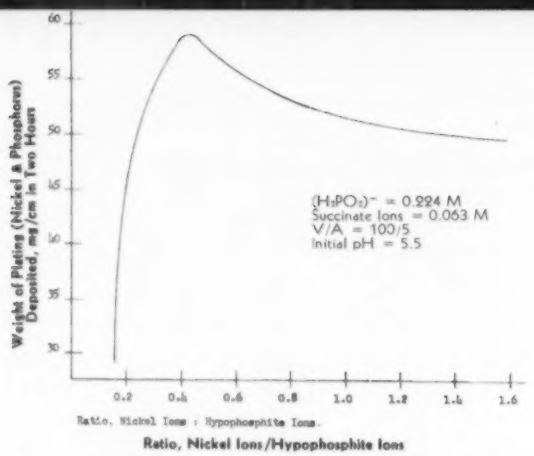


Fig. 18. Rate of deposition from succinate bath as a function of $Ni^{++}/[H_2PO_2]^-$ molar ratio. Compare with Fig. 15, noting difference in scale of vertical coordinate.

TABLE XVIII

DEPOSITION RATE AS A FUNCTION OF LACTATE CONCENTRATION

Lactate Concentration M.	0.08	0.16	0.24	0.30	0.40	0.60
Plating Rate						
R × 10^4 g/cm²/min....	2.82	3.80	3.96	3.53	3.46	3.01
Phosphite Tolerance M...	—	0.18	0.35	0.55	1.40	—
Ni^{++}/Lactate.....	1.00	0.50	0.33	0.27	0.20	0.13

lactic anion concentration of about 0.25 would be the desirable optimum, the phosphite tolerance would not be satisfactory at that level. A practical compromise is, therefore, a bath containing about 0.35–0.40 M of 2-hydroxy-propionic ion, which gives roughly a rate of 3.5 × 10^{-4} g/cm²/min (1.0 mil/hour) and a phosphite tolerance better than 1.0 M. Furthermore, at this concentration, sodium lactate-lactic acid is a good buffer system in the desirable *p*H range.*

Of course, it is also possible to use several chelating or complexing agents in various proportions, such that all the Ni^{++} cations are "tied up"—which requires at least two carboxyl groups and one center of coordination per mole of nickel—plus eventually, an "exaltant" in order to compensate for the concomitant lowering of the coating rate.[24]

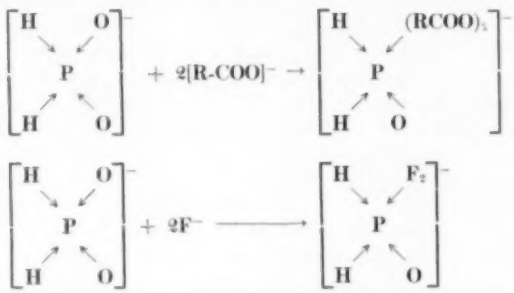
A published example (Example IV in reference 33) of such a bath composition* is as follows:

Nickel ions (as nickel sulfate)	0.07 M
Hypophosphite anions (as sodium salt)	0.230 M
Lactic anions	0.200 M
Malic anions	0.06 M
Succinic anions	0.200 M
Lead sulfide (stabilizer)	1 ppm Pb^{++}
*p*H adjusted to 4.6 with NaOH	

Exaltants

"Exaltants" are specific anions which, when added to a chemical plating bath, increase the rate of deposition, (and also allow extension of the $Ni^{++}/[H_2PO_2]^-$ ratio). The term was selected because of the hypothesis proposed originally for explaining the mechanism of their action. It is well known that reactions can be positively "catalyzed" by complex formation. For instance, boric acid, which is weakly dissociated, becomes a strong acid upon addition of organic polyhydroxyl compounds, such as mannitol. The dissociation constant can thus be raised in the ratio of 1:10^4 (Germanic acid H_2GeO_3 is another similar example). Ordinary molybdates are difficult to reduce to "molybdenum blue," while phosphomolybdates are rapidly and completely reduced. This phenomenon is known as "exaltation" in the French chemical literature.

It is believed that the catalytic action of certain anions in chemical nickel plating may be due to heteropoly-acid formation, i.e., replacement of one oxygen atom in the hypophosphite molecule considered as a coordination compound by foreign acid radicals. This concept can be schematically illustrated by representing the acids of phosphorus (according to Werner) as complex molecules (Reference 3, page 724):



This would in turn, through steric repulsion, weaken the (direct) phosphorus-hydrogen bond, and consequently favor dehydrogenation of the hypophosphite complex. (Of course, it is also possible to assume a Brönsted type of acid-case catalysis.) Whatever the mechanism, experimental evidence shows that the presence of a number of aliphatic short-chain saturated anions and of at least one inorganic anion (F^-) in proper concentrations increase substantially the deposition rate of the nickel-phosphorus alloy, all other conditions remaining equal.[25, 26, 27]

Three classes of organic acids have been found to be efficient "exaltants:"

1. Saturated unsubstituted short-chain aliphatic dicaboxylic anions[25], namely malonic, succinic, glutaric and adipic (in order of decreasing effectiveness).—The last, although cheapest, is not sufficiently water soluble, and the first is too expensive and not readily available. Consequently, the succinate ion is the preferred specie.* Fig. 18 shows the rate at increasing $Ni^{++}/[H_2PO_2]^-$ ratios (maximum at about 0.4), while Fig. 19 indicates the effect of initial *p*H variation for a

*Patented in the United States and abroad.

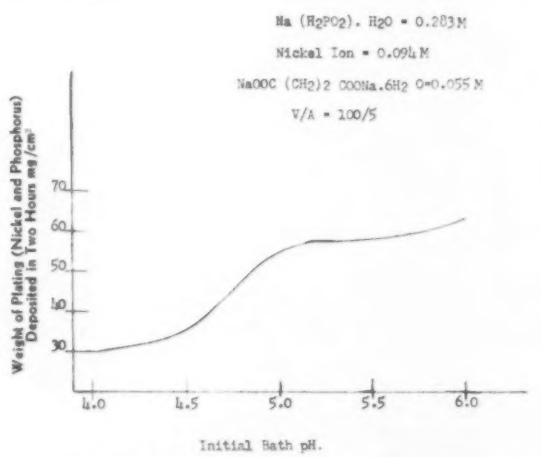


Fig. 19. Rate of deposition from succinate bath as a function of initial pH. Compare with Fig. 15, noting difference in scale of vertical coordinate.

*Patented in the United States and abroad.

TABLE XXI

"EXALTATION" EFFECT OF SUCCINATE

Bath Composition	No. 1		No. 2		No. 3	
	g/l	M	g/l	M	g/l	M
Nickel chloride, Tech.	30.0	0.126	30.0	0.126	21.4	0.09
Sodium hypophosphite 87.9 per cent, Tech.	10.0	0.094	10.0	0.094	23.9	0.225
Hydroxyacetic acid M.P. 77–79C	7.0	0.092	—	—	—	—
Sodium citrate U.S.P.	—	—	10.0	0.034	—	—
Sodium succinate, Tech.	—	—	—	—	16.2	0.06
Results						
Bath 1 (Hydroxyacetic Anion)						
Initial *p*H	6.4		5.5		5.0	4.5
Rate R × 10^4 g/cm²/min	2.5		1.9		2.1	2.7
Bath 2 (Citric Anion)						
Initial *p*H	—		5.5		5.0	4.5
R × 10^4 g/cm²/min	—		1.8		1.8	1.8
Bath 3 (Succinic Anion)						
Initial *p*H	6.1		5.5		5.0	4.5
R × 10^4 g/cm²/min	5.0		5.6		5.1	4.6

bath containing no other organic additive. Table XX gives test results of two comparative runs, one with acetic acid, the other with succinic acid as organic additives (buffers, exaltants).

TABLE XX

RATE OF DEPOSITION AS A FUNCTION OF ORGANIC ADDITIVE

Temp 99C—Initial *p*H = 5.1

Bath Composition	V/A = 50/20	= 2.5
$[H_2PO_2]^-$ M	0.122	0.122
Ni^{++} M	0.075	0.075
Acetate anion M	0.115	—
Succinate anion M	—	0.077
Weight increase (10 min)	0.0732	0.1232

Table XXI shows other examples, comparing rates obtained at several *p*H values with Brenner's hydroxyacetate bath and citrate baths with a chemical plating solution containing succinate.

The most interesting characteristic of these "exaltants" is their ability to enhance the plating rate to practical values of 1 mil/hr or more, in the presence of chelating or complexing agents—which (with the exception of lactic acid and amino-acids) normally reduce the plating rate. Table XXII gives supporting test data.

TABLE XXII

COMPARISON BETWEEN RATES IN COMPLEXED BATH WITH AND WITHOUT "EXALTANT"

Bath Composition

Nickel chloride ..... 0.0675 M
Sodium hypophosphite ..... 0.225 M
Ammonium hydroxide ..... 0.135 M
Stabilizer (Pb^{++}) ..... 1.0 ppm
*p*H adjusted to about 5.0 respectively 5.5 with hydrochloric acid
The bath contained enough ammonium ions to "tie up" all the nickel ions present as the nickel diammine cation.

Results

Exaltant (Succinate Ion) M	Zero	0.03	0.06	0.06	0.09
Initial *p*H	5.03	5.01	5.00	5.51	5.03
Plating rate R × 10^4 g/cm²/min	0.06	2.53	4.02	4.86	5.16

As can be seen, the rate of deposition without addition of any "exaltant" is negligible, and certainly unsuitable for practical plating purposes. It is raised to better than 1.4 mils/hour by the presence of 0.09 M of succinate anion, i.e., an increase of 86 fold.

Table XXIII shows results obtained by adding an "exaltant" (succinate) to two of Brenner's standard electroless plating solutions (containing respectively hydroxyacetic acid and citric acid).

TABLE XXIII

EFFECT OF "EXALTANT" ADDITION TO BRENNER & RIDDELL BATH

Bath Composition (M)	1*	2	3	4	5
Nickel chloride	←		0.126		→
Sodium hypophosphite	←		0.094		→
*p*H	←		4.6		→
Hydroxyacetic (glycollic) acid	0.092	0.092	0.092	0.152	0.212
Sodium succinate	—	0.06	0.12	—	—
Total concentration of organic additives	0.092	0.152	0.212	0.152	0.212

Plating Results (duplicates)

Rate R × 10^4 g/cm²/min

1	2	3	4	5
1.93–1.84	3.44–3.42	3.55–3.60	1.81–1.79	2.36–2.33

*Brenner and Riddell preferred bath composition.

Note that the total concentration of organic additives is identical for baths 2;4 and 3;5—but the deposition rate from baths 2 and 3 (containing succinic anion as an "exaltant") is considerably increased.

Other valuable organic exaltants are:

2. Aliphatic short-chain saturated amino-acids (patent pending), which are also excellent chelating agents (and fair buffers at higher *p*H values than the hydroxy-acids) and can thus perform a triple action. Glycine (amino-acetic acid) is a typical example.

3. Short-chain saturated (non-substituted) aliphatic acids, i.e., homologues of the series acetic to valeric, the preferred specie being the propionate anion.[27]

Table XXIV gives experimental results to substantiate the above statement.

TABLE XXIV

Bath Composition

Nickel ions (from nickel sulfate)	0.08 M
Hypophosphite ions (from sodium hypophosphite)	0.225 M
Lactic ions (from lactic acid)	0.300 M

Results

Exaltant Anion M	Zero	Acetic 0.03	Propionic 0.03	Butyric 0.03	Valeric 0.03
Initial *p*H	4.73	4.70	4.70	4.70	4.70
Plating rate R × 10^4 g/cm²/min	3.53	3.98	4.41	4.00	3.88

While these simple saturated aliphatic anions are far less effective than both the dicarboxylic and the amino carboxylic radicals, they are cheap and easily available.

The only inorganic "exaltant" discovered so far[26] is the fluoride ion.* Its one drawback is the fact that the permissible concentration range is quite small, so that control is critical. On the other hand, presence of the F^- ion is particularly advantageous in the plating of amphoteric metals (aluminum, magnesium, titanium, etc.). Table XXV offers some data in support of the above statement, for tests run at various *p*H values. The bath used here contained no chelating agent, but succinate in the amount of 0.06 M as buffer and organic exaltant. Nickel ion concentration (as $NiCl_2$) was 0.09 M, and hypophosphite concentration was 0.225 M.

It will be noted that, upon addition of 0.10 M of F^- anion to the succinate bath, the rate of deposition (at *p*H 4.5–4.6) is more than doubled. On the other hand, an excess of fluoride destroys bath stability.

Stabilizers

While a properly compounded chemical plating solution can be relatively stable for several hours or even a few days under normal operating conditions, decomposition may occur suddenly and unexpectedly.* This is probably the most serious and frustrating problem in a production plant, as it represents a heavy loss in materials, time and labor.

Bath decomposition is always triggered by the presence, in the solution, of solid nuclei (of colloidal or near-colloidal dimensions). The probable mechanism (supported by experimental evidence obtained in General American Transportation Corporation's laboratory) is the existence of hydroxyl ions at the surface of the solid particles, which will cause localized reduction of nickel ions to the metal (sponge) by homogeneous reaction (III). This "black precipitate," in turn, acts as a highly efficient catalyst (due to its nature and large surface), thus starting a self-accelerating chain reaction.

The solid nuclei mentioned above can be of intraneous or extraneous origin. The latter case is mostly due to accidental causes and poor "housekeeping" (dust, welding fumes, etc.); while the former is a natural phenomenon, resulting from precipitation of basic salts or hydroxides of some cations even at the lowest normal operating *p*H. (This, incidentally, is another reason for keeping the hydrogen ion concentration as high as possible, and for using broad spectrum chelating agents in the bath). For instance, among the common metal ions, both Fe^{+++} and Al^{+++} form gelatinous $Fe(OH)_3$, as well as basic phosphite, at *p*H values below 5.0. Because these metals are the most usual substrates for chemical coating, baths in industrial production shops will build up their content of these foreign cations (through the essential displacement reaction and ordinary chemical attack) until the concentration in Fe^{+++} and/or Al^{+++} becomes sufficient for nucleation. Moreover, as mentioned before, nickel orthophosphite will also eventually reach the critical limit.

It was found that certain dehydrogenation anti-catalysts (catalytic poisons), added to the chemical plating solution in *trace amounts* will act as stabilizers, thereby preventing random decomposition.[20, 29]

While their mode of action can only be demonstrated by indirect methods, it is believed that these ions are adsorbed preferentially—and, of course, at a higher density because of the small radius of curvature—at the surface of the colloidal or near-colloidal micelles, thus preventing further random catalytic decomposition of the bath by means of their selective shielding, respectively "poisoning" effect.

The amount of these inhibitors is quite critical. For instance, the presence in the plating solution of HS^- ions at concentrations around one part per million (1 ppm) will completely stop deposition; while, at concentrations of the order of about ten parts per billion (0.01 ppm) these anions act as stabilizers. To maintain a constant supply of HS^- ions at this low level (despite the high temperature of the bath which volatilizes H_2S), traces of thio-compounds such as alkali thiosulfates, thiourea, ethylxanthate, etc., may be added, which supply continuously a very low concentration of HS^- anions through hydrolysis. "Insoluble" sulfides of heavy metals are also suitable for the same purpose.[20]

Not all catalytic dehydrogenation poisons are effective stabilizers. Some have such a narrow range that their use is totally impractical. Others are not sufficiently active under plating conditions; still others are volatile or decomposed by reaction with bath components.

A remarkable property of several such stabilizers is the fact that, when added in very small quantity (measured in parts per million), they improve the plating rate. Of course, as their amount is increased above this optimum, the rate decreases until complete "poisoning" (i.e., no deposition) occurs.

*In a 1954 article, Dr. A. Brenner wrote[2]: "Occasionally, the life of an electroless plating bath comes to an untimely and sudden end through spontaneous decomposition. This phenomenon begins first with a mild, uniform evolution of gas throughout the volume of the bath, instead of only on the surface of the metal parts. The gassing becomes more vigorous, the solution begins to froth somewhat, and a black precipitate appears in the bath. Finally, the gas evolution becomes so vigorous that the entire contents of the vessel foams over . . ."

TABLE XXV

Fluoride ion (M)	Zero	0.10	0.10	0.10	0.10	0.10	0.15	0.15	0.225
Initial *p*H	4.60	4.0	4.50	5.00	5.50	6.00	5.0	5.70	4.60
Duration of Test (min)	60	60	60	60	60	60	66	66	60
Weight Gain (20 cm² steel samples)	0.0975	0.1387	0.2297	0.2495	0.2599	0.2643	0.2621	0.2374	0.1544
Stability (Time to black precipitate)	Stable	Stable	Stable	Stable	Stable	Stable	26 min	45 min	34 min

Stabilizers can be roughly divided into three classes,* which overlap in certain areas:

1. Organic and inorganic thio-compounds,[20]

2. Organic dipolar anions containing (a) a long chain comprising at least 8 carbon atoms and (b) an acidic functional group (carboxyl, enol, mercapto, etc.) suitable for oriented adsorption and therefore hydrophobic film formation.[20]

3. Cations of heavy metals able to form "insoluble" sulfides stable under plating conditions (i.e., in a chemical plating bath at plating temperature).[20]

In order to determine stabilizing ability of the numerous ions investigated, several methods have been used, such as electrometric (E.M.F.) measurements, precise analysis (nickel distribution) after plating to depletion, and observation of an inherently unstable bath (using highly purified chemicals).

*Patented in the United States and abroad.

An example of such a plating solution is one containing:

Nickel hypophosphite, recrystallized . . 0.09 M Ni^{++}
Sodium hypophosphite, recrystallized . 0.045 M $[H_2PO_2]^-$
Sodium succinate, recrystallized . . . . . 0.060 M
Sodium chloride, C.P. . . . . 0.18 M
*p*H adjusted to 4.6 with pure HCl

In these simple tests, stability is determined by the time in minutes before visible "black precipitate" (i.e., nickel-phosphorus sponge) is formed, at an acceptable rate of deposition (at least 3.0 g/cm²/min × 10^4). The bath (without addition of stabilizing ions) shows incipient decomposition after 15–20 minutes, at plating temperature (95C+).

The following examples are illustrative of the action of stabilizing ions belonging to the three groups already mentioned. Precleaned mild steel samples of 20 cm² area were used. Plating rate is given in R × 10^4 g/cm²/min. Appear-

TABLE XXVI[20]

STABILIZING EFFECT OF TRACE IONS

A—**First group** (thio-compounds)

Stabilizer ppm of $S_2O_3^{--}$	None	0.5	1.0	5.0	10.0
Plating rate	4.59	4.53	4.63	4.56	0.02
Time to black precipitate (minutes)	20	30	stable	stable	stable
Sample appearance after 60 minutes	B-SR	D-S	D-S	B-S	D-R

Stabilizer ppm of ethylxanthate	None	1	5.0	10.0	50.0	250.0
Plating rate	4.59	4.76	4.90	4.92	4.55	0.01
Time to black precipitate (minutes)	20	45	stable	stable	stable	stable
Sample appearance after 60 minutes	B-SR	B-S	B-S	B-R	D-S	D-R

Stabilizer ppm of thiomalic acid	None	0.5	1.0	5.0	10.0	50.0
Plating rate	4.59	3.87	4.50	4.51	4.60	0.02
Time to black precipitate (minutes)	20	5	10	stable	stable	stable
Sample appearance after 60 minutes	B-SR	D-SR	B-S	B-S	B-S	D-R

B—**Second group** (heavy metal cations)

Stabilizer ppm of Pb^{++}	None	0.01	0.04	0.07	0.10	0.20	0.50	1.0	10.0	50.0
Plating rate	4.59	4.94	4.93	5.18	4.54	4.97	4.49	4.69	2.77	None
Time to black precipitate (minutes)	16	37	37	43	stable	stable	stable	stable	stable	stable
Sample appearance after 60 minutes	B-S	BB-S	BB-S	BB-S	BB-S	BB-S	BB-S	BB-S	BB-S	—

Stabilizer ppm of Sn^{++}	None	0.1	0.5	2.0	10.0	50.0	100.0
Plating rate	4.59	5.32	5.36	5.68	4.99	4.56	4.26
Time to black precipitate (minutes)	16	40	40	stable	stable	stable	stable
Sample appearance after 60 minutes	B-S	B-S	B-S	B-S	B-S	B-S	B-S

Stabilizer ppm Te^{++++}	None	0.1	1.0	5.0	10.0
Plating rate	4.59	3.33	2.34	2.34	2.15
Time to black precipitate (minutes)	16	stable	stable	stable	stable
Sample appearance after 60 minutes	B-S	B-S	BB-S	VB-S	VB-S

C—**Third group** (long-chain organic dipoles)

Stabilizer ppm of potassium oleate	None	10.0	25.0	50.0	75.0
Plating rate	2.98	—	2.89	2.71	—
Time to black precipitate (minutes)	10	10	15	15	stable
Sample appearance after 60 minutes	BB-S	BB-S	BB-S	BB-S	BB-S

Stabilizer ppm of Armac T*	None	1.0	5.0	10.0	25.0	50.0
Plating rate	3.25	3.29	1.46	0.89	0.04	0.03
Time to black precipitate (minutes)	13	13	stable	stable	stable	stable
Sample appearance after 60 minutes	BB-S	BB-S	BB-S	Sp-S	Sp-S	Sp-S

*Armac T is a tallow amineacetate manufactured by Armour and Co., consisting essentially of 30 per cent hexadecylamineacetate, 25 per cent octadecylamineacetate and 45 per cent octadecenylamineacetate.

ance of the specimens is indicated by the following symbols: B—semi-bright (satin); Bb—bright; VB—very bright; S—smooth; SR—slightly rough; R—rough; D—dull; Sp—spotted.

As can be seen from the data presented in Table XXVI, the thiosulfate anion, for instance, starts to stabilize at a concentration of 1.0 ppm (parts per million), with a good rate of deposition. At a concentration of 5 ppm, the rate is still suitable; while, at 10 ppm, it is much too low. Similarly, the stabilization range for sodium ethylxanthate is from 5.0 to 50.0 ppm; for thiomalic acid from 5.0 to 10.0 ppm; for the lead cation from 0.10 to 1.0 ppm; for the tin cation, from 2.0 to 100 ppm, etc. These limits apply only to the bath composition used, but are typical of the general behavior of these negative catalysis controllers. Other baths will give somewhat different stabilizing ranges, but roughly within the same order of magnitude, i.e., from about 0.1 to about 200 parts per million.

By maintaining in the plating solution a proper stabilizer concentration (trace amounts), the bath can be operated without danger of decomposition until its phosphite tolerance limit is reached.

KANIGEN® Process

KANIGEN® plating baths are characterized by their patented composition. For the reasons discussed above, they contain nickel cations (derived, for instance, from nickel sulfate hexahydrate) and hypophosphite anions (derived, for instance, from sodium hypophosphite monohydrate) in a ratio of $Ni^{++}/[H_2PO_2]^-$ of from 0.15 to 1.60 M, preferably 0.3 to 0.4 M, in aqueous solution. In the presence of "exaltants" and chelating agents, the absolute concentration of hypophosphite ions can be between 0.15 and 1.20 M, and is preferably 0.220–0.250 M. An organic chelating agent, also functioning as a buffer, is added in sufficient concentration not only to complex all the nickel ions, but to allow a phosphite tolerance of 1.0 M $[HPO_3]^{--}$ or better. Preferred species are lactic acid, amino-acetic acid, malic acid or mixtures thereof. An "exaltant" is added in order to increase deposition rate to about 1.0 mil/hour or more, counteracting the slowing effect of the chelating agents. Preferred species are succinic and propionic anions. Controlled trace amounts of stabilizers prevent solution decomposition by "masking" active nuclei. Preferred species are lead (sulfide), thiourea and thiosulfates. The bath is usually adjusted to a *p*H of 4.4–4.8. Control methods are also provided.[20]

In addition, the process comprises specific chemical pretreatment procedures adapted for cleaning and activating a large number of metal alloys and non-metallic substrates.[16, 17] Furthermore, it includes operating techniques which involve continuous circulation of the bath through a hot (coating) and a cold (handling) section, with pumping, filtration and regeneration confined to the latter.[21, 22] Means have been developed to prevent wasteful nickel deposition on the plating tanks and heater walls.[23] Finally, methods for chemical bath recovery (after the latter has reached the nickel phosphite precipitation level) have been worked out.[23] As a result, the process is a safe, easily operated and economic industrial system which has proven itself in large-scale production since 1952.

ACKNOWLEDGMENT

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[33]U. S. Patent 2,872,354 to W. G. Lee, Feb., 1959 (Filed Dec. 31, 1954), Assignor GATC, plus two allowed and one pending applications.

Dr. Gregoire Gutzeit became associate director of General American Transportation Corporation's Research and Development Department in 1953, after holding the positions of Director of GATC's Research and Testing Laboratory, and of Research Director of the Process Equipment Division, since 1944.

Dr. Gutzeit was raised and educated in Switzerland, receiving a BA from Calvin College, Geneva in 1919. Subsequent degrees were earned at the University of Geneva: MS in chemical engineering and geological engineering (1927); PhD in chemistry (1929); DS in chemistry and metallurgy (1932). In addition, Dr. Gutzeit was a chemistry instructor from 1926 to 1929. From 1929 to 1932 he held a position in the geological research departments of Union Miniere du Ht. Katanga (Belgian Congo). From 1932 to 1941, he was a member of the University of Geneva faculty of sciences, during which time he also served as a consultant for Swiss, American, French, Swedish and Dutch firms. In 1941, he came to this country as development engineer in charge of metallurgical research with the Dorr Co., Inc.

A licensed engineer in the State of Indiana, Dr. Gutzeit is co-author of a handbook on qualitative mineral analysis, and author of numerous articles on chelate chemistry, semi-microanalysis, mineral concentration, industrial waste treatment, chemical nickel plating. He holds a large number of U. S. and foreign patents in those fields. He is a fellow of the American Association for the Advancement of Science, a member of the American Institute of Chemical Engineers, the American Institute of Mining and Petroleum Engineers, the American Chemical Society, the American Society for Testing Materials and of several scientific groups in Europe.

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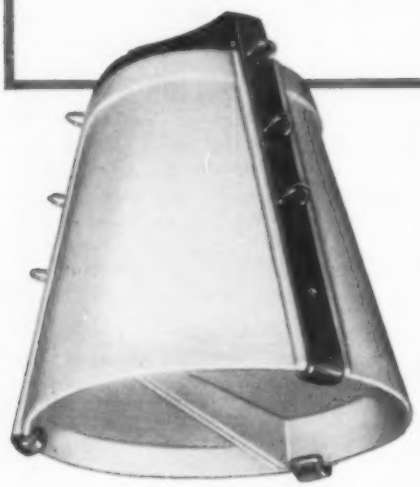

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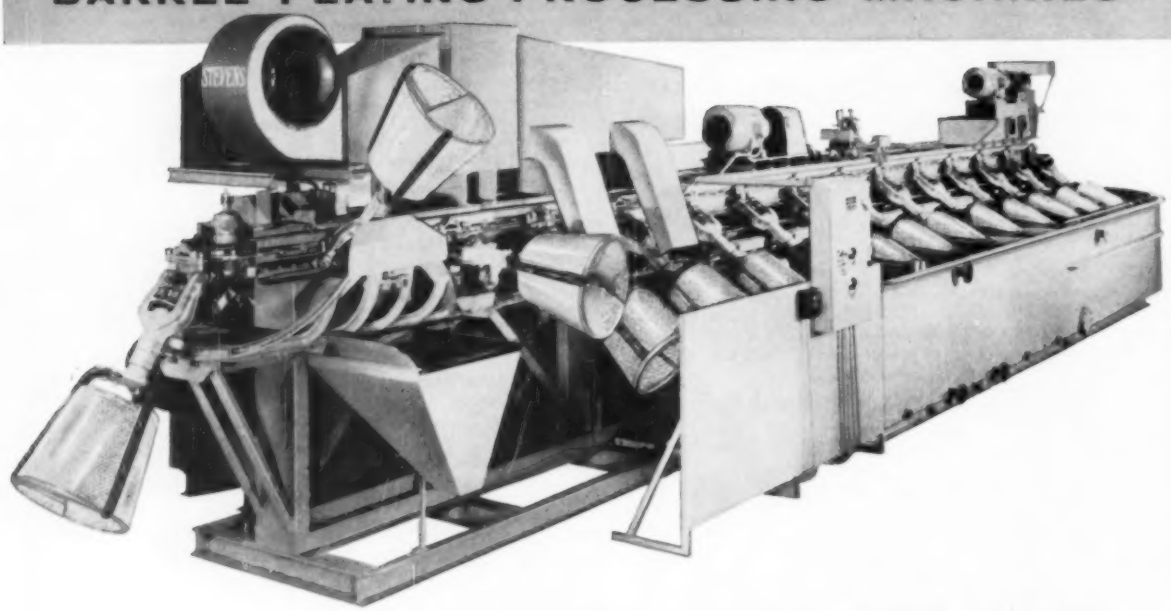

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LARGER and larger AES membership, and the Society's driving ambition to enrich technical knowledge and advancements in electroplating, metal finishing and allied arts, created need to broaden the frequency and scope of AES's official journal. Consequently, in June 1914—in that same month that Austria declared war upon Serbia thereby launching World War I—QUARTERLY REVIEW became MONTHLY REVIEW.

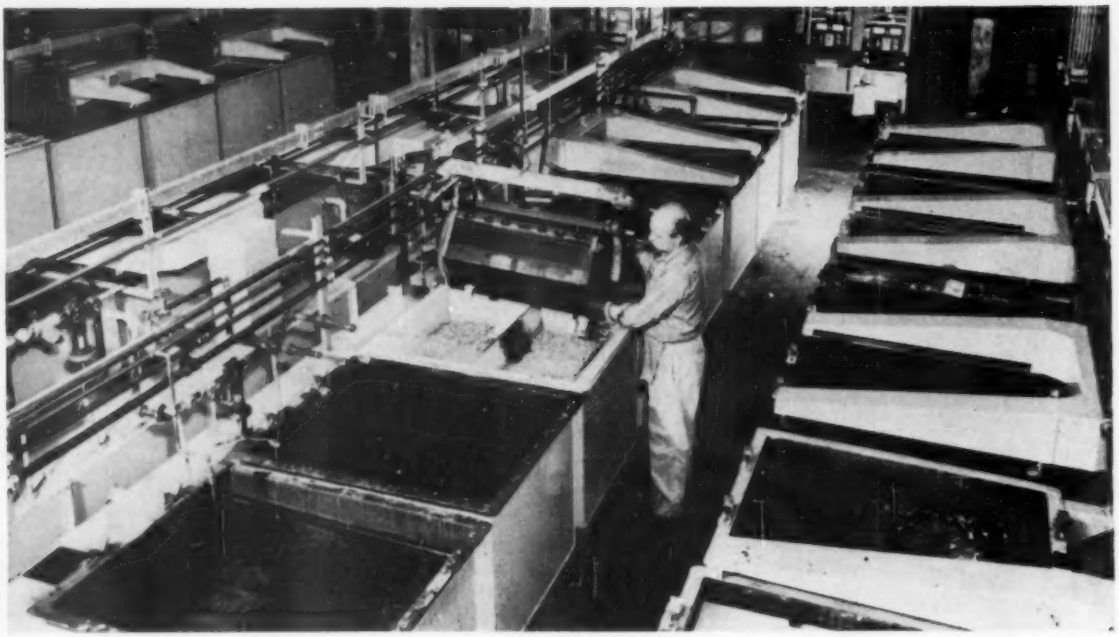
A PAPERBOUND booklet still 6 x 9 inches in size but now embodying more pages and broader editorial range, that June 1914 pioneer issue of AES's MONTHLY REVIEW was edited by H. E. Willmore of Chicago. Associate Editors were AES Founding Father Charles Henry Proctor; First AES President George B. Hogaboom; then-National President J. H. Hansjosten; Chicago Branch President Oscar E. Servis and AES members Harry de Joannis (Bridgeport Branch); Fred J. Liscomb (Chicago Branch) and Ernest Lamoureaux (Chicago Branch).

THE next third-of-a-century saw MONTHLY REVIEW keep pace with AES's structural, functional and educational progress—still concentrated upon advancing knowledge in plating, metal finishing and allied arts. From a humble quarterly, it grew, step-by-step, into a prestige monthly, still 6 x 9 inches in page size, still fully owned by, and still fully tailored for, AES's swelling membership.

IN that same third-of-a-century, a number of innovations occurred in MONTHLY REVIEW's policy and format. The most noteworthy took place in September 1933, in the nadir of our nation's most drastic economic depression. That month, MONTHLY REVIEW appeared for the first time carrying the product advertising of six industrial companies. From that juncture, through the years, more and more such enterprises entered the family of MONTHLY REVIEW's product advertisers—most of whom have ever since consistently advertised in that publication, then PLATING MAGAZINE, its successor, to AES's great pride in their continued and continuing confidence.

NEED by 1947 to transform and expand MONTHLY REVIEW so as to enable burgeoning AES to meet the broader vista of its destiny ahead, resulted in the metamorphosis of MONTHLY REVIEW from a 6 x 9 inch size magazine to a monthly magazine with an 8¼ x 11¼ inch paper trim and 7 x 10 inch type area. In December 1947, AES published its last MONTHLY REVIEW—in January 1948—embodying "New Look" and other features of progress—today's PLATING MAGAZINE made its debut. The name, PLATING, was chosen by AES's Executive Board through its "New Name Contest." Proposed by Robert E. Moore, a member of AES's Newark Branch, it was selected from among 132 entries.

GROWING parallel with its AES parent through the years since then, PLATING MAGAZINE observes its own FIFTIETH ANNIVERSARY in 1960, a far cry from the historic 6 x 9 inch paperbound, 28-page QUARTERLY REVIEW of June 1910 from whose seed it blossomed. It is a member today of the Audit Bureau of Circulations and of the Society of Business Magazine Editors. It is indexed in Applied Science and Technology Index, and is abstracted regularly in Chemical Abstracts, Metals Review, Metallurgical Abstracts, Engineering Index, Technical Data Digest and Bulletin Analytique. Enjoying the largest audited paid circulation in its field, and the highest paid subscription renewal percentage, it is a monument to those many dedicated members of AES who created it and who developed it through the vicissitudes of five decades from QUARTERLY REVIEW to MONTHLY REVIEW to PLATING MAGAZINE of 1960.



Plating facilities in a steel plant—tanks, plating barrel and control panels are part of the equipment shown here.

THE FIELD THAT PLATING MAGAZINE SERVES

PLATING serves the electroplating and metal finishing industry. This rich field includes all plants engaged in the finishing of metals and of certain non-metals. Electroplating and metal finishing constitute almost 50 per cent of the metal-working industry, the biggest of all industrial markets.

THE INDUSTRY: ITS BEGINNINGS

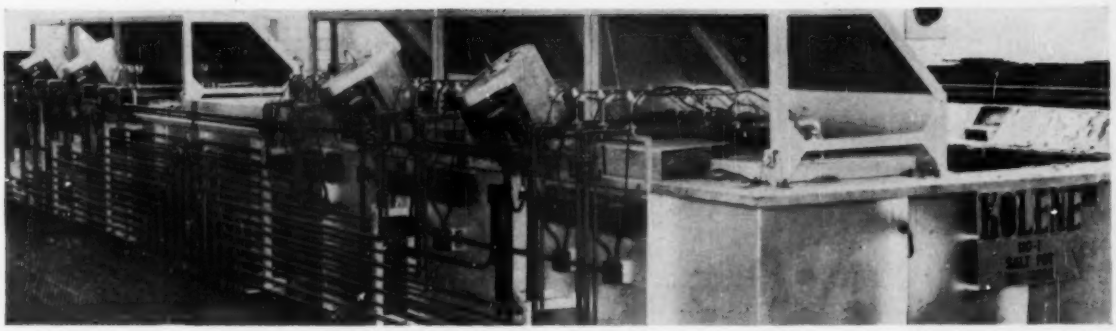
Metal finishing and the coating of one metal upon another are among the oldest processes known to man. Ever since the day when man first used metal, he started to burnish, sharpen, shape, and generally change the surface to meet his requirements of hardness, strength, beauty, durability and other properties. It was not until the late Eighteenth and early Nineteenth Centuries that experiments were conducted on various methods of metal finishing by electrolytic means. Titans such as Galvani, Volta, Ohm, Cruikshank, Davy, Faraday, Nobili, Bird, Smee, Jacobi and Boettger are only a few of the renowned scientific names in history that have left their mark upon this fabulous industry.

The industry is constantly at work trying to find newer, faster, more economical, more durable, and more protective finishes for various items of everyday and specialized uses. Continuous research is going on in various university and research laboratories, manufacturing plants, and job shops throughout the world. The American Electroplaters' Society itself conducts a broad research program in addition to the research carried on by the industry in general. It thus expends many thousands of dollars yearly in the interest of progress in electroplating, metal finishing and allied arts.

THE INDUSTRY: ITS FUNCTION

Electroplating, essentially, is the process of depositing electrolytically a metal upon another material (also usually a metal) to obtain an adherent coating or plate. This coating is deposited upon the basis material to protect it from corrosion or wear, or simply for decoration. Electric current is passed through a specially prepared solution that contains salts of the metal to be plated on the base. While the material is being deposited by the electric current on the basis material, an anode usually dissolves in the plating solution to maintain its metal concentration. In certain instances, insoluble anodes are employed and salts are added to keep up the metal concentration.

Industrially, electroplating includes all of those activities that directly pertain to the production of a plated surface; the preparation of the surface by polishing, buffing and tumbling; the cleaning of the surface; the electrodeposition itself; and any further finishing desired. Considered more broadly, electroplating also involves a number of other surface treatments. These may be either *electrolytic*, such as the anodizing of aluminum and magnesium and electropolishing—or *nonelectrolytic*, such as oxide and sulfide treatments. When final organic coatings are applied to electroplated surfaces, this operation is also considered a phase of electroplating.



Salt bath process at plant in Huntington, West Virginia

THE INDUSTRY: PLANTS COMPOSING IT

Electroplating installations are generally found in two types of plants:

(a) The electroplating departments located in manufacturing plants responsible for finishing products fabricated in those plants. These represent about 80 per cent of this country's finishing installations.

(b) The plating and finishing contract shops which represent about 20 per cent of all the installations and which may vary from two or three man enterprises to plants with many hundreds of employees.

THE INDUSTRY: ITS GEOGRAPHICAL CONCENTRATION

The bulk of the industry is located in the New England, Middle Atlantic, and East North Central sections of the country. In addition, there is growing activity in the South Atlantic, West North Central, and Pacific Coast and other areas of the United States and the Dominion of Canada.

THE INDUSTRY: OTHERS THAT IT SERVES

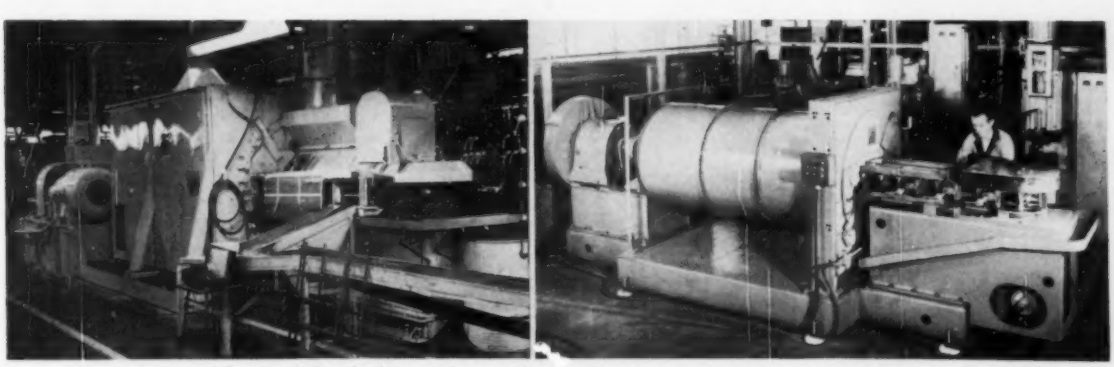
Major divisions of industry that use electroplating include the following and many others:

Automotive
Architectural
Aviation
Bicycle
Clock and Watch
Communications Equipment
Cutlery
Electrical Apparatus
Engine and Turbine
Farm Machinery
Food Container
Furniture
Hardware
Household Appliance
Industrial Equipment and Machinery
Jewelry
Kitchen Equipment
Lighting Fixture
Musical Instrument
Novelty and Toy
Office Equipment
Optical and Photographic
Ordnance
Precision Instrument
Printing
Radio
Railroad
Shipbuilding
Silverware
Surgical and Dental Equipment
Tableware
Telephone
Television
Tool and Machine

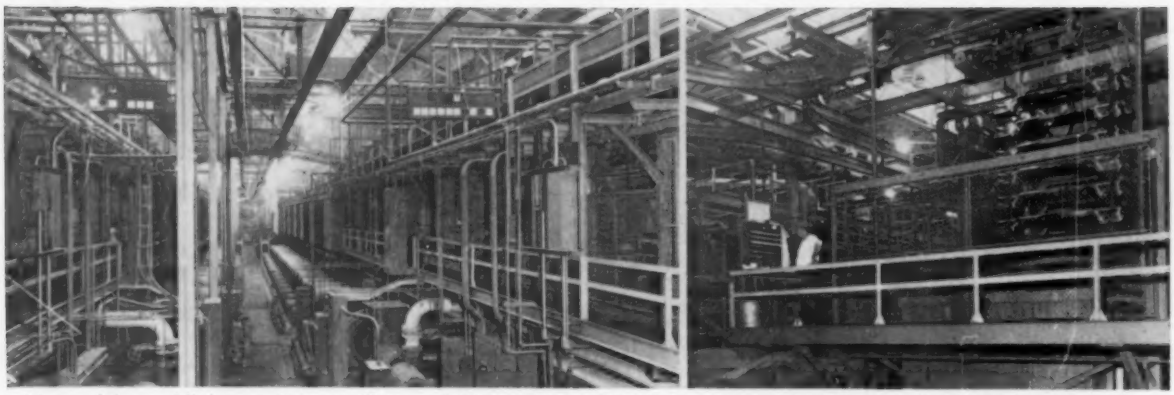
THE INDUSTRY: INVESTMENT AND PRODUCTION

Equipment and supplies for polishing and buffing, tumbling, burnishing, cleaning, washing, degreasing, rinsing, descaling, pickling, plating, drying, and organic finishing, as well as for anodizing, electropolishing, phosphatizing, chromatizing, and oxidizing are required by electroplating installations. Additional equipment is needed for quality control and for experimentation. Plating plants also require equipment and supplies for ventilation; for filtration; water purification; dust collection; waste disposal; and to protect workers, equipment and buildings from deleterious materials.

Plants in the United States, estimated to be in excess of 8,000 in number, have invested many millions of dollars in such plating and finishing equipment. Wearing quality and sales appeal characterize electroplated products. The worth added to any finished product by electroplating and allied finishing processes may vary from a fraction of the total cost of the article to a large ratio thereof. It is estimated that the total annual value of plating and finishing operations in this country is over a half billion dollars.



Horizontal Gyrofinishing machines and conveyors at automotive plant in Flint, Mich.



Views of the world's largest plating installation. (left) Center aisle of the plating section. (right) Carrier and rack with bumpers ready to enter the plater.

THE INDUSTRY: METALS THAT IT USES

ALUMINUM—used extensively in vacuum metalizing and in anodizing.

CADMIUM—provides a corrosion protective coating with an attractive appearance on various basis metals.

CHROMIUM—nontarnishing, durable surface finish for decorative purposes on metal; "hard" chromium for wear resistance, low coefficient of friction, and resistance to corrosion and erosion; "porous" chromium plate for motor parts to make engines last longer.

COPPER—used for coating prior to deep drawing and wire drawing; for protection during selective carburizing; undercoat for protective nickel chromium coatings on steel and zinc base die castings; for decorative purposes; for electrotypes and electroforming.

GOLD—resistant to tarnish, oxidation and attack by most chemicals. Used extensively in jewelry and in specialized industrial applications.

INDIUM—thin plated coating on engine bearings and other specialized applications for corrosion and wear resistance.

IRON—largely used in electroforming such as molds and printing plates; in building up worn or underdimensioned steel parts.

LEAD—used on nuts, bolts, brackets for outdoor use; used to plate bearings; good for corrosion protection, especially against sulfuric acid.

NICKEL—most important metal applied by electroplating because of the diversity of uses. Effective in combating corrosion; protective and decorative coating usually under chromium; electrotypes; building up worn parts, electroforming.

PLATINUM—high melting point and resistant to oxidation and attack by most acids.

RHODIUM—final coating on an increasing number of items to impart a nontarnishing surface. Used largely in the jewelry and electronic field. Also gives excellent reflectivity.

SILVER—applied to a wide variety of basis metals and alloys; exhibits unique properties in the decorative household electrical, chemical and mechanical fields.

TIN—used for resistance to corrosion and tarnish on steel strip for can making, on food trays, on bearings, etc.; for soldering, on electrotype backs, on wire, etc.

ZINC—offers protection against rust; used on a variety of items such as wire products, pipe fittings, and for hardware in all fields.

Racking of small parts at the plating tank.

THE INDUSTRY: PRODUCTS THAT IT USES

In addition to anodes, acids and salts, a partial list of products employed by the industry includes:

Abrasive belts—Abrasive blasting equipment—Abrasives—Acid-proof products—Acid-resistant products—Activated carbon—Agitators—Air compressors—Air heaters—Ammeters—Ampere-hour meters—Anode bags—Aprons, rubber and synthetic.

Baking enamels—Baking ovens—Balls, cones, pins and slugs—Barrels, plating and tumbling—Baskets, and carriers—Batteries—Battery chargers—Belt polishing machines—Blast cleaning equipment—Blowers, pressure and exhaust—Boilers, steam (for tank heating)—Booth coating—Boots, rubber and synthetic—Brick, acid-proof—Brighteners—Bronze powders—Brushes, tampico—Brushes, wire—Buffing compositions—Buffs—Burners, gas—Burnishing balls and chips—Burnishing compounds—Bus bars.

Cabinets, humidity—Cable and wire—Canvas polishing wheels—Carbon brushes and specialties—Carboy pumps and rockers—Cells; Haring and Hull—electrolytic—Cement, acid-proof—Cement brushes—Cements and adhesives—Chemicals—Cleaners, alkali and emulsion—Cleaners, metal—Cleaning and washing machines—Clothing, protective—Coatings—Coils—Coil handling equipment—Colorimeters, spectrophotometers—Communication systems—Composition applicators—Condulets—Connectors, electrical—Controls, electrical—Crocks, acid-proof.

Degreasing machines—Deionizing and water softeners—Detergents—Dips for corrosion protection—Dryers, centrifugal—Drying ovens—Dust collecting systems—Dyes for anodizing—Electrical fittings and connectors—Electric motors and equipment—Emery paste—Enamels.

Felt polishing wheels—Fillers—Filter aids—Filter bags—Filter paper—Filters, air—Filters, solution—Finishers and finishing equipment—Fire fighting equipment—First-aid equipment—Flooring materials, special—Floors, acid-resistant.

Gears and drives—Generator brushes—Generators, motor—Gloves, rubber and synthetic—Glue—Glue pot heaters—Goggles—Grinding wheels.

Heat exchangers—Hoists—Honing machines—Humidity cabinets.

Idlers and backstands—Indicators, papers and test sets—Inhibitors, acid—Instruments and controls—Ion exchange resins.

Japans.

Laboratory equipment and supplies, general—Lacquers—Lamps, baking—Lighting equipment—Lubricants—Lubricating equipment and lubricating systems.

Magnets—Marking equipment—Masking tapes—Materials handling equipment—Metal Cleaners—Metals, ferrous and non-ferrous—Motor generator sets—Motors, electric.

Nozzles.

Oil seals—Oils and lubricants—Ovens, baking and drying.

Packings—Pickling equipment—Pipe and fittings—Plating machines, automatic and semi-automatic—Plugs and receptacles—Polishing and buffing lathes—Polishing and buffing machines, automatic—Polishing wheels—Primers—Pumice—Pumps—*p*H instruments.

Rack coating material—Racks—Rectifiers—Regulators—Respirators—Rinsers—Rouge—Rubber linings—Rust preventives.

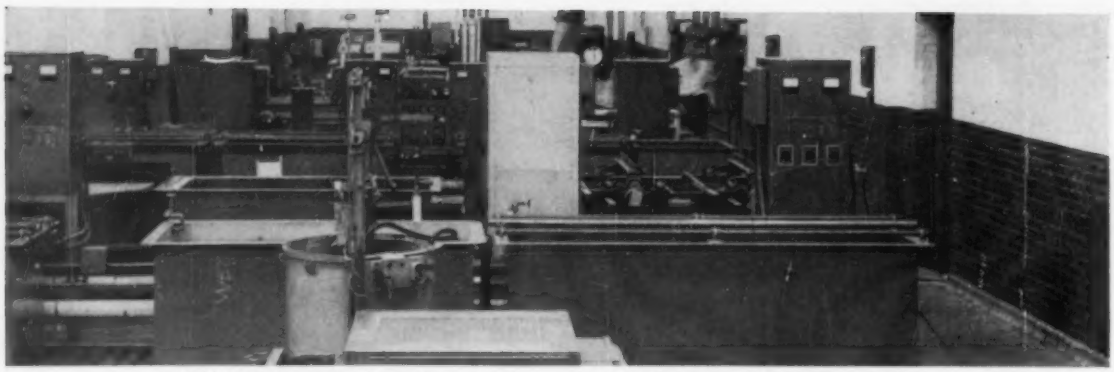
Safety equipment—Salt spray testing equipment—Sawdust—Sawdust shaking machines—Sheet felt—Skin-protective creams and liquids—Slitting machines and equipment—Solvents, degreasing—Speed reducers—Spray booths—Spray guns—Steam traps—Stop off materials—Strainers, pipeline.

Tanks, ceramic—Tanks, glass—Tanks, metal—Tanks, plastic—Tanks, rubber and plastic lined—Tanks, wood—Temperature regulators—Test sets—Thickness gages—Thinners—Titrimeters, potentiometric—Tongs—Tools, power and hand—Tripoli—Tumbling equipment

Vacuum pumps—Valves—Vapor degreasing equipment—Varnishes—Ventilating fans and systems—Voltmeters.

Welding equipment—Washing machines—Wetting agents—Wire and cable.

Horizontal plating at a steel plant. The anode is being inserted.



A U. S. Government electroplating installation, showing the plating and pretreatment shop.

THE INDUSTRY: ALLOY METALS COMMONLY USED

Alloy metals that can be deposited include the following:

Brass	Lead-Tin	Silver-Cadmium
Bronze	Nickel-Cobalt	Silver-Lead
Copper-Zinc-Tin	Nickel-Iron	Tin-Zinc
Gold-Nickel-Copper	Nickel-Molybdenum	Tungsten-Iron
Gold-Silver	Nickel-Zinc	Tungsten-Nickel
Lead-Thallium	Platinum-Iridium	Zinc-Cadmium
	Platinum-Rhodium	

THE INDUSTRY: OTHER DEPOSITABLE METALS

The following metals can be deposited from certain baths, but are not generally employed because of expense and scarcity impracticability, or because they do not supply a particular need. Changing requirements, however, may at some later date, increase their application.

Actinium	Manganese	Rhenium
Antimony	Mercury	Selenium
Arsenic	Molybdenum	Tellurium
Bismuth	Niobium	Thallium
Cobalt	Palladium	Tungsten
Germanium	Polonium	Zirconium

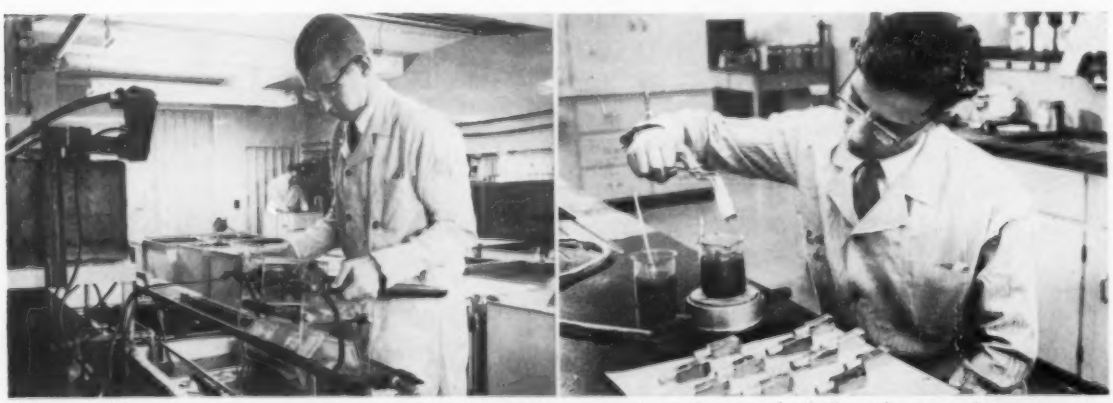
THE INDUSTRY: METALS RECEPTIVE TO COATING

The metals to which electroplated coatings are applied include all of the metals in common use, including

Aluminum	Lead	Steel (stainless)
Brass	Magnesium	Tin
Bronze	Nickel	Tin alloys
Copper	Nickel Alloys	Zinc
Iron	Steel	Zinc alloys

The following less common metals are now finding special applications, for certain of which plating coatings may be required:

Beryllium	Titanium	Uranium
Molybdenum	Tungsten	Vanadium
Thorium		Ziconium



Pilot plant laboratory at plating research center. (Left) Included are 41 tanks, each with individual rectification and temperature controls. Technician in foreground is operating plating barrel. (Right) Researcher is evaluating a new cleaning agent for the removal of buffing compounds.

THE INDUSTRY: INDUSTRIAL CHEMICALS USED

Acetic acid
Alum
Aluminum sulfate
Ammonium bifluoride
Ammonium carbonate
Ammonium chloride
Ammonium hydroxide
Ammonium nitrate
Ammonium persulfate
Ammonium, di, phosphate
Ammonium sulfate
Ammonium thiosulfate
Antimony trichloride
Antimony trioxide
Arsenic trioxide
Asbestos
Barium carbonate
Barium sulfide
Beeswax
Beta Naphthol
Boric acid
Cadmium oxide
Calcium chloride
Calcium hypochlorite
Calcium polysulfide
Calcium sulfate
Carbon, activated
Carbon disulfide
Caustic potash
Caustic soda
Chromic acid
Citric acid
Cobalt acetate
Cobalt ammonium sulfate
Cobalt chloride
Cobalt sulfate
Copper(ic) chloride
Copper cyanide
Copper fluoborate
Copper pyrophosphate
Copper sulfate
Cream of tartar
Dextrose
Diethylene triamine
Fluoboric acid
Gelatin
Glue, animal
Glycerin
Gold chloride
Gold cyanide, potassium
Hydrochloric acid
Hydrofluoric acid
Hydrogen peroxide
Indium chloride
Indium sulfate
Iron(ous) ammonium sulfate
Iron(ic) chloride
Iron(ous) chloride
Iron fluoborate
Iron phosphate
Iron(ic) sulfate
Lead acetate
Lead carbonate, basic
Lead fluoborate
Lead sulfamate
Manganese phosphate
Manganese(ous) chloride
Merury(ic) chloride
Molasses
Molybdic acid
Muriatic acid
Nickel acetate
Nickel ammonium sulfate
Nickel carbonate
Nickel chloride
Nickel fluoborate
Nickel formate
Nickel sulfamate
Nickel sulfate
Nitric acid
Oxalic acid
Palladium ammino nitrite
Palladium chloride, sodium
Paraffin wax
Peptone
Perchlorethylene
Phenolsulfonic acid
Phosphoric acid
Platinum diammino nitrite
Potassium acid tartrate
Potassium carbonate
Potassium chloride
Potassium cyanide
Potassium gold cyanide
Potassium hydroxide
Potassium nitrate
Potassium permanganate
Potassium, di, phosphate
Potassium pyrophosphate
Potassium silver cyanide
Potassium stannate
Rhodium phosphate
Rhodium sulfate
Rochelle salt
Silver cyanide
Silver cyanide, potassium
Soda ash
Sodium acetate
Sodium bicarbonate
Sodium carbonate
Sodium chloride
Sodium chlorite
Sodium citrate
Sodium cyanide
Sodium dichromate
Sodium hydrosulfite
Sodium hydroxide
Sodium hypophosphite
Sodium nitrate
Sodium nitrite
Sodium, di, phosphate
Sodium, tri, phosphate
Sodium, tetra, pyrophosphate
Sodium polysulfide
Sodium silicate, meta
Sodium silicate, ortho
Sodium stannate
Sodium sulfate
Sodium sulfide
Sodium thiocyanate (sulfocyanide)
Sodium thiosulfate (hyposulfite)
Sodium tripolyphosphate
Sodium tungstate
Stearic acid
Sulfamic acid
Sulfuric acid
Tartaric acid
Thiourea
Tin(ous) chloride
Tin(ous) fluoborate
Tin(ous) sulfate
Trichlorethylene
Triethanolamine
Vienna lime
Zinc cyanide
Zinc dust
Zinc phosphate
Zinc sulfate

* The many and widespread analytical and research laboratories connected with the plating industry are a fertile market for a wide variety of reagent grade chemicals not included in this list.

THE INDUSTRY: A LOOK AHEAD

Although the industry has been established in the United States on a commercial scale for more than three-quarters of a century, its full potential has yet to be realized. New techniques with correspondingly better finishes, production streamlining and economic savings are coming to light constantly. Fundamental research is currently under way to enhance understanding of the entire phenomena of plating and finishing. Plating on plastics, on glass and on other nonmetallic substances is still in the experimental state compared with the significance it is expected ultimately to earn. Electroforming as a tool of production is opening new vistas to the industry.

The importance of electroplating and allied metal finishing is becoming increasingly apparent to sales-minded executives and design engineers—and new product specifications call for products finished for greater sales appeal and durability. Electroplating does an outstanding job for both of these requirements. Its horizons, consequently, are still unlimited.

Photographs are published in the order of their appearance through the courtesy of Standard Pressed Steel Company, Kolene Corporation, General Motors Corporation, Ford Motor Company and The Udylite Corporation, E. I. du Pont de Nemours and Company, Weirton Steel Company, U. S. Navy, and Enthone, Inc

PLATING MAGAZINE ADVERTISERS

As a phase of its FIFTIETH ANNIVERSARY observance, PLATING publishes this list in appreciation to each and every one of its advertisers. The companies starred are those that have advertised in MONTHLY REVIEW (PLATING's ancestor) from 1933 (start of the book's acceptance of product advertising) through 1947, and in PLATING MAGAZINE since 1948 when MONTHLY REVIEW became today's PLATING MAGAZINE.

A & P Finishing & Mfg. Co.
Abbey Process Automation Inc.
*The Abbott Ball Company
Abrado Finish Corporation
*Acme Mfg. Company
Acme Specialty Co.
Acoustica Associates, Inc.
Adams Engineering Co.
Agate Lacquer Mfg. Co., Inc.
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Allied Research Products Inc.
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*American Instrument Co.
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Better Finishes & Coatings Inc.
*Bias Buff Div., Reigel Textile Corp.
Bison Corp.
G. S. Blakeslee & Co.
Boonton Radio Corp.
Branson Ultrasonic Corp.
Broadway Rubber Corp.
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Bush Mfg. Co.
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Cargille Scientific Inc.
Carma Manufacturing Co.
Casalbi Co.
*The Ceilcote Co.
Chandeysson Electric Co.
Chase Brass & Copper Co.
Chase Buff Co.
Chautauqua Plating Co., Inc.
*The Chemical Corp.
Chemical Processing Co.
Chemical Products Corp.
Chemsteel Construction Co.
Chem-Wear Inc.
Chicago Rubber Co., Inc.
Chrome Engineering, Inc.
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Engelhard Industries, Inc.
Enley Products, Inc.
*Enthone, Inc.
Erie Engine & Mfg. Co., Erie Degreaser Div.
The Exolon Co.
Falcon Mfg. Co., Inc.
Fall Industries, Inc.
Fiber Chemical Corp.
Filter Paper Co.
W. D. Forbes Co.
Forcite Corp.
*Formax Manufacturing Corp.
W. M. Fotheringham Co.
*Paul Frank
Fulton Asphalt Co.
The G. S. Equipment Co.
The G. & S. Plastics Co.
Garfield Buff Co.
Gates Electronic Co.
General American Transportation Corp., Kanigen Division
*General Chemical Co.
*General Electric Co.
General Plate Division, Metals & Controls Corp.
General Ultrasonics Co.
Gerell Manufacturing Co.
Paul H. Gesswein & Co., Inc.
The Globe Chemical Co., Inc.
Glo-Quartz Electric Heaters
*Grasselli Chemical Co.
Graver Water Conditioning Co.
Grav-I-Flo Corp.
Great Lakes Carbon Corp., Dicalite Div.
Great Lakes Foundry Sand Co.
Great Lakes Nickel Co., Inc.
Green Electric Co., Inc.
Grieve-Hendry Co., Inc.
Guaranteed Buff Co., Inc.
*Frederick Gumm Chemical Co., Inc.
*Hammond Machinery Builders, Inc.
Hampshire Chemical Corp.
Handy & Harmon
*Hanson-Van Winkle-Munning Co.
Harding Chemical Corp.
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*Industrial Filter & Pump Mfg. Co.
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Metal Finishing Mfg. Co.
Metallurgical Products Co.
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Metal Treating Equip. Exchange
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*Michigan Chrome & Chemical Co.
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*Mitchell Bradford Chemical Co.
*Munning & Munning Co. Inc.
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Natural Products Co.
Nazar Rubber Company
Nelson Chemicals Co.
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New England Rack Co.
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Olin Mathieson Chemical Corp.
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F. D. Pace Electroplating Eng. & Equip.
*Packer Machine Co.
Paddock Pool Equipment Co.
Papesch & Kolstad, Inc.
Wm. Parker Co.
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The Permutit Co.
Pesco Plating Equipment Corp.
Phelps Dodge Refining Corp.
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Phoenix Abrasive & Chemical Co.
Photovolt Corp.
Pioneer Rubber Co., The
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Platers Supply Co.
The Plating Products Co., Inc.
Plating Products-Kokomo
Por-O-Met
Powers Regulator Co.
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Procter & Gamble Co.
*Promat Div., Poor & Co.
*Pyrene Manufacturing Co.
Pyrosil, Inc.
J. Nelson Quinn Co.
Radio Receptor Co., Inc.
Rampe Mfg Co.
Randall Mfg. Co., Inc. (RAMCO)
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Riegel Textile Corp., Bias Buff Div.
Robe, Inc.
Roberts Rouge Co.
Rockwell Lime Co.
William Rosenthal & Co.
Rossani Co.
Rotel Manufacturing Co.
Roto Finish Co.
*Rumford Chemical Works
Sabin Metal Corp.
*Sarco Co., Inc.
Sauereisen Cements Co.
Schaffner Mfg. Co., Inc.
Schori Process Div. Ferro Co.
*E. E. Seeley Co. Inc.
Sellers Engineering Co.
*Sel-Rex Corporation
Servi-Sure Mfg. Co.
Sethco Manufacturing Co.
*The Seymour Mfg. Co.
Shell Chemical Corp.
*J. J. Siefen Co.
Siefen Compounds, Inc.
Silvercrown, Ltd.
Smoothex Inc.
Sosmetal Products
South Florida Test Service
*Sparkler Mfg. Co.
Special Chemicals Corp.
Spraying Systems Co.
Stainless Steel Corp. of America
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*Standard Plating Rack Co.
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AES NEWS

THREE CANDIDATES NAMED FOR HONORARY MEMBERSHIP

Three Branches, namely Detroit, New Haven and Southeastern, have placed candidates before the AES Honorary Membership Selection Committee for consideration, each an AES stalwart with a distinguished record of AES service over a long span.

If favorably considered by that Selection Committee, the three candidacies will then be channeled by that Committee to the Executive Board for ratification. Passage by the Board will qualify the three names to be nominated for upgrading to AES Honorary Membership at the Supreme Society meeting to be held in Los Angeles, July 28, 1960.

The Selection Committee is headed by Leslie L. Diveley and includes Charles C. Conley, Dr. Samuel Heiman and Anthony P. Julius. At this writing, the AES proudly boasts of thirteen living Honorary Members.

AES's 1959-1960 GOVERNORS ACCREDITED

Designated and certified by Branches through their respective Branch Presidents and Secretaries, elected Branch Delegates/Alternates to compose the Supreme Society, AES's highest governing council, during 1959–1960 have now been accredited by the Credentials Committee. From National Headquarters, consequently, each such accredited Delegate or Alternate Delegate has now received not only his credentials card and a copy of the booklet, "Delegates Manual," but also a copy of the up-to-date AES Constitution and Bylaw booklet.

The 1959–1960 Credentials Committee is headed by Past President Arthur W. Logozzo and includes Past President Cleveland F. Nixon and Past Louisville Branch President Stanley J. Beyer.

SPECIAL BOARD MEETING FINALIZES MANY PENDING POLICY MATTERS

Convened in special session held at the Statler-Hilton Hotel, Detroit, Michigan, December 5, the AES Executive Board, among other policy business transacted, approved the preliminary budget of the AES's 47th Annual Convention, to be staged at the Statler Hotel, Los Angeles, July 24–28, 1960, as submitted by Walter P. Behlendorf, Host Branch Finance Chairman, in behalf of the Los Angeles Branch Convention Committee.

Los Angeles $25 Convention Fee Set

Compelled by the fact that the Los Angeles 1960 Convention will be AES's first such venture west of the Rockies, and that distance and transportation costs may reduce normal attendance without commensurate reduction of most Convention costs, the Executive Board found it necessary to approve, for "breakeven" safety, the $25 per adult (male or female) registration fee urged by the Los Angeles Convention Committee. In taking this step because of these extraordinary circumstances, the Board made it clear that it did so without establishing a precedent.

The Board also approved an $18 per child registration fee covering four well-programmed, fun-filled days for children, including admission costs to places to be visited (including Disneyland), transportation, chaperones, box lunches and other such day-to-day expense—but not including the Farewell Banquet. Banquet tickets will separately be available for children at standard Banquet price.

Detroit Exposition's Audit Statement Approved

The Board also studied and approved the certified audit statement prepared by Earle R. Damaske, independent certified public accountant of Detroit, and submitted to the Board by Exposition Committee Chairman Howard J. McAleer, covering the AES Fifth Industrial Finishing Exposition held in Detroit, June 15–19, 1959. The Board authorized acceptance of the $20,007.42 net profit of said Exposition certified by said independent public accountant, and it ordered its deposit in full to the credit of the AES's General Fund.

Empowers Publishing Hydrogen Embrittlement Book

The Executive Board also empowered the National President and the National Executive Secretary to enter the AES into a contract with a leading scientific book publishing company by which said publisher will publish, in book form, the technical papers to be delivered by experts before the AES's "Hydrogen Embrittlement in Metal Finishing Symposium" at the 1960 Los Angeles national convention, after said papers have first appeared in the AES's book, TECHNICAL PROCEEDINGS (1960 Edition).

The book proposed will not only include the delivered hydrogen embrittlement papers themselves, and the transcript of the discussion that will attend the delivery of each such paper, but will also be supplemented by additional data on hydrogen embrittlement to be marshaled by Dr. Harold J. Read, Professor of Physical Metallurgy, Pennsylvania State University, AES Editor of that special AES book.

Following its Educational Sessions held at the Robert Treat Hotel, Friday, December 11, AES's Newark Branch conducted its annual Christmas Party at the same site, Saturday evening, December 12. (Left) A view of the pre-dinner cocktail party hosted cooperatively by the industry's suppliers. (Center) A part of the well-attended banquet. (Right) A table of AES stalwarts including, from bottom left, Philadelphia Branch President James E. Cogan Jr.; Ezra Blount, "Products Finishing;" Law Committee Chairman Manson Glover; Mrs. Swift; Past President George P. Swift; Mrs. Wagner; MFSA Secretary A. P. Munning; AES First Vice President W. A. Wesley and Past President George J. Wagner.

TECHNICAL PAPER ABSTRACTS
AEROSPACE FINISHING SYMPOSIUM

SPONSORED BY
SOUTHWEST SOCIETY OF AIRCRAFT AND MATERIALS ENGINEERS
AND
DALLAS-FORT WORTH BRANCH, AMERICAN ELECTROPLATERS' SOCIETY, INC.

HOTEL TEXAS, FORT WORTH, TEXAS, DECEMBER 8-9, 1959

1. "Nickel Plating by Chemical Reduction" **by Dr. G. Gutzeit, General American Transportation Corporation**

Nickel-Phosphorus alloy deposition by chemical (catalytic) reduction has recently gained prominence among methods which provide improved surface properties to aerospace engineering. The coating is uniform regardless of the shape of the part, hard, and highly corrosion resistant. Heat treatment can create outstanding wear properties. The paper describes the fundamental chemical reactions, the physical, chemical and metallurgical properties of the plating and gives a number of illustrative examples of applications in the field of flight engineering.

2. "New Developments in Precious Metal Plating" **by A. Korbelak, Sel-Rex Corporation**

The author presents a brief review of previous methods; then a detailed discussion is given on new precious metal coatings. This includes descriptions of low-stress, crack-free rhodium, heavy ductile coatings of platinum, coatings of pure gold, and a complete coverage of alkaline and acid bright gold and bright alloy gold deposits.

3. "Vacuum Deposited Coatings for Aircraft, Space Vehicles, and Missiles" **by P. J. Clough, National Research Corporation and H. M. Farrow, NRC Equipment Corporation**

Functional vacuum deposited coatings as applied to aircraft, space vehicles, and missiles are discussed. Present uses of vacuum coatings for protection from corrosion and hydrogen embrittlement in steels, control of electro-magnetic energy transfer, miniaturization of electronic circuits, and other uses are explained. New uses of vacuum coatings are predicted.

4. "High Temperature Coatings for Aerospace Applications" **by J. R. Myers, Applications Division, W.A.D.C. Ohio**

A discussion of the need for protective coatings for high temperature materials, particularly the refractory metal alloys, is presented. Various coating techniques, their advantages and limitations, are described for both thermal insulation and oxidation resistance purposes. Specific examples where high temperature protective coatings have been advantageously utilized in aerospace applications are included.

5. "The Screening of Material Systems for High Temperature Applications" **by Lt. L. N. Hjelm, Applications Division, W.A.D.C. Ohio**

A description of the philosophy necessary for the design of meaningful high temperature material systems screening tests and for the proper evaluation of the screening data. A standardized high temperature material systems screening tests, currently undergoing feasibility trials, is described and substantiated in light of the aforementioned philosophy.

6. "Surface Protection of Metals for Atmospheric Reentry by the Diffusion Technique" **by R. L. Wachtell, Chromalloy Corporation**

The paper deals with the W-2 process for the protection of molybdenum, columbium, and certain of the super alloys for resistance to oxidation at high and very high temperatures. Certain simulated re-entry test data and other pertinent data are presented. Techniques of application and coordination of design to the coating technique will finalize the discussion.

7. "Utilization of Pigmented Coatings for the Control of Equilibrium Skin Temperatures of Space Vehicles" **by G. A. Zerlaut, A.B.M.A., Redstone Arsenal, Alabama**

The ability to tailor-make solar absorptivity-emissivity ratios have made the use of pigmented coatings very attractive for space vehicle applications. Painted surfaces are discussed as a means of affecting temperature control of space vehicles. Means of affecting temperature control, their advantages and disadvantages are outlined. Future needs as covered relative to possible specialized pigmented coatings.

8. "Experimental Application of Arc and Flame Sprayed Coatings" **by J. D. Walton, Jr. and C. R. Mason, Jr.**

The paper describes the work being carried out at Georgia Tech in the study of arc and flame sprayed coatings. The purposes of these coatings are to provide oxidation and thermal protection, through insulation or emissivity, to underlying structures. The types of coatings produced and factors controlling the properties of such coatings are discussed. A method is described for producing refractory shapes by spraying.

9. "Some Important Factors in Coatings for High Temperature" **by Dr. C. L. Faust, Battelle Memorial Institute**

Coatings for high temperature protection involve uncommon basis metals and uncommon coatings. Some chemical and metallurgical situations not faced by coatings for low-temperature needs are discussed relative to high temperature requirements and properties. Diffusion and interdiffusion aspects appear quite important in coating consideration. Time savings in coatings developments may be realized by initial consideration of several important factors, i.e., bond strength, etc.

10. "Developments in Aluminum Finishing" **by R. E. Pettit, The Diversey Corporation**

The paper outlines phases of cleaning practices, developments, and a review of early work of anodic oxidation pointing out electrolytes and specific applications. Electroplating on aluminum is considered with emphasis towards the zincate and sulfuric acid anodic treatments. Various chemical coatings are discussed with aspects directed towards porcelain enameling.

11. "Electroforming for Aircraft and Missiles—A Survey" **by M. Rubinstein, Marlane Development Company**

This paper surveys the field of electroforming as an advanced fabrication technique, primarily emphasizing work on aircraft and missiles. A brief description of the advantages of electroforming will be followed by a summary of some of the electrodeposition developments which have enabled fundamental advancements in this technique. Lastly, the paper describes a number of interesting recent applications, illustrating these by slides.

(*Continued on page 86*)

DIXIE REGIONAL, JANUARY 15-16 IN VACATIONLAND MIAMI BEACH

Complete with a two-session, top quality educational program—a leisurely, never-to-be-forgotten set of ladies events in balmy Florida climate—sightseeing of vacationland Miami and its day and evening attractions—a farewell banquet, floor show and dance—the AES's two-day Second Annual Dixie Regional Meeting will be held at Miami Beach's Saxony Hotel, January 15-16, 1960 with the AES's Miami Branch as Host.

Chairman of the event is Marmaduke H. Dent of Pan American Airways, a founder of the Miami Branch and currently its Immediate Past President.

TO ALL BRANCH SECRETARIES

1. **Your Branch President and you as Branch Secretary have now received from National Headquarters, your Branch's Return Sheet through which your Branch can nominate any qualified member in good standing whom it pleases for the 1960 CHARLES HENRY PROCTOR MEMORIAL LEADERSHIP AWARD, the AES's highest non-technical, non-scientific honor. That Return Sheet, properly signed by your Branch President and by yourself, should be in the hands of the National Executive Secretary by or before April 1, 1960 for consideration by the Award's Selection Committee for this year's Award. Your Return Sheet, to be acceptable to the Selection Committee, must be accompanied by SEVEN copies of a statement of accomplishments of your nominee buttressing his nomination.**
2. **Your Branch will soon receive from National Headquarters, a reasonable quantity of a two-color, accordion-fold combination AES membership promotion piece and Application Blank. Initiated by the National Membership Committee and prepared by Headquarters, these leaflets are intended to assist your Branch to increase its membership. The new item does not replace "AES Membership: Its Meaning to YOU" so successfully being used by National Headquarters in answering membership inquiries, particularly for Membership-at-Large. It supplements it.**
3. **Many Branches have accepted the Public Relations Committee's recommendation and are distributing copies of the vaunted booklet, "MILESTONES OF AES," among their new members. Reasonable quantities are still procurable from Headquarters without charge for Branch use for such purpose.**

The luncheon audience that heard Convair's Dr. W. A. Orr discuss "Interesting Aspects of Space Vehicles," December 9.

AEROSPACE FINISHING SYMPOSIUM ATTENDED BY REGISTRANTS FROM 25 STATES

Registrants from 25 states heard the 17 papers composing the four educational sessions of the "Aerospace Finishing Symposium" held at the Hotel Texas, Fort Worth, December 8–9, 1959, jointly sponsored by the Southwest Society of Aircraft and Material Process Engineers (SAMPE) and the Dallas-Fort Worth Branch of American Electroplaters' Society, Inc. (AES) according to Program Chairman Myron E. Browning, President of the AES's Dallas-Fort Worth Branch. General Chairman was D. C. Novelli of SAMPE and of Convair, Fort Worth.

The four sessions covered the subjects of "Metal Deposition and Plating Processes"; "Coatings for the Future"; "Special Processes and Finishing Treatments" and "Organic Coatings and Polymeric Finishes". Luncheon speaker on December 8 was Dr. F. C. Jonah of Chance Vought Aircraft, Inc. who discussed "Where We Are and Where We're Going in the World of Space". Dr. W. A. Orr of Convair treated, "Interesting Aspects of Space Vehicles" at the December 9 luncheon. A Finishing Forum on Wednesday evening completed the significant two-day event.

Colonel Thurston T. Paul, Deputy Commander of the Army Ballistics Missile Agency, Redstone Arsenal, Alabama, was the principal banquet speaker on the evening of December 8 and captivated his audience with, "The Moon and Six Pence". Other speakers were Mayor John Justin of Fort Worth; Frank W. Davis, Vice President, Convair Division of General Dynamics Corporation; AES National Executive Secretary John P. Nichols and Mr. Browning. General Chairman Novelli presided at the large assembly which later enjoyed a floor show provided by the "Chain Gang", a well-known local orchestra.

At a meeting held Monday morning, December 7, a proposed coordinated AES research project on aerospace finishing subjects was discussed with AES Research Chairman James D. Thomas and other members of the AES Research Committee present. That same afternoon, preliminary discussions occurred pointed toward the possible formation of an informal AES Southwest Regional Council. The Dallas-Fort Worth, Houston, Kansas City, Denver and Phoenix Branches were represented, and the Wichita Branch has also indicated interest in such a project. Myron E. Browning was named Chairman Pro-Tempore to coordinate the development of organizational plans preliminarily discussed subject to Branch consideration and action.

National Executive Secretary Nichols was the principal speaker at the Dallas-Fort Worth Branch's monthly meeting, Monday evening. Research Chairman Thomas also discussed the AES Research Program.

(Left) Two of the speakers at Tuesday evening's banquet. Colonel Thurston T. Paul at left with Frank W. Davis, vice president of the General Dynamics Corporation. (Right) One of the impressive displays at the Symposium's Exposition. From left, General Chairman D. C. Novelli, AES National Executive Secretary John P. Nichols and Program Chairman Myron E. Browning Jr.

(*Continued from page 84*)

12. "Precious Metal Coatings for Special Depositions and Surface Treatments" **by R. T. Hopper, Hanovia Liquid Gold Division of Engelhard Industries, Inc.**

Thin films of gold, gold-palladium and platinum are excellent reflectors of infrared radiation. Economical films of these metals are being produced commercially on aluminum, stainless steel, titanium, porcelain enamelled steel, glass, ceramics, and high temperature plastic laminates. The noble metal films are being used on engine shrouds, drag-chute containers, blast shields, tail-cone assemblies and furnace reflectors. A dense 24 karat gold film can be plated on a variety of metals by ionic displacement.

13. "Hard Anodizing of Aircraft and Missile Components" **by Dr. H. J. Wiesner, Bendix Aviation Corporation**

Hard anodizing has been employed in aircraft fuel metering components for several years with excellent success. Its limitations in these applications are discussed. The extension of hard coat to aircraft wheel and brake components is included. Preparation for and finishing of hard coated components is discussed. Methods of precision thickness control, and quality control of hard coat are outlined. The Taber Abraser is evaluated for checking abrasion resistance.

14. "A Better Priming System" **by W. H. Smith, Allied Paint Manufacturing Company**

The epoxy resin primer properly modified to achieve maximum water resistance and carefully formulated with corrosion resistant pigments will outperform other formulations in almost all cases under 325F. Adhesion to a clean surface and extremely low permeability offer advantages to the process control engineer unobtainable in other finishing systems.

15. "Organic Coatings" **by E. D. Hood, The Glidden Company**

This paper deals with organic coatings for aircraft, missiles, and space vehicles. The properties of coatings required for each of these applications are outlined. A description of newer types of coatings (catalyzed epoxies, modified catalyzed epoxies, vinyl-acrylic, silicone, modified baked silicone, silicone acrylic, polyurethane, emulsions) are given.

16. "High Temperature-Resistant Organic Coatings" **by Dr. M. A. Glaser, R. E. Caplan, and R. W. Clope, Midland Industrial Finishes Company**

The advent of silicone coatings designed to promote more effective temperature and corrosion control of high speed aircraft, missiles and space vehicles is discussed. Their uses for identification, nuclear bomb radiation reflection, corrosion protection, and high electrical resistivity are presented. Data are presented comparing physical properties of a number of aluminum pigmented silicone coatings. The properties of silicone-ceramic hybrids designed to protect metallic substrates up to 1400F are reviewed.

17. "Development and Application of Polyurethan Coatings in the Air Force" **by A. S. Dalton, Applications Divisions, W.A.D.C., Ohio**

As a result of the Air Force materials development program, polyurethan coatings are finding broad application on ground equipment, aircraft and space vehicles. These coatings exhibit good reflectivity and excellent durability under conditions of high thermal flux. They maintain high gloss, have excellent abrasion and erosion resistance and low temperature flexibility. The chemical nature of the basic ingredients of these materials make them very versatile "building blocks" for further developments.

Above, Convair's lovely publicity chief affixes name plate of Dallas-Fort Worth Branch's president, Myron E. Browning Jr., as Aerospace Symposium general chairman and SAMPE'S head look on. Below, another view of a typical exhibit.

Eduardo Sanchiz, Technical Manager of Sanchiz y Bueno S.A., visited AES National Headquarters prior to his departure for Spain. Left to right above, Rodney Leeds, Mr. Sanchiz and John P. Nichols.

SPANISH SCIENTISTS TOUR AMERICAN PLATING CENTERS

Under the joint sponsorship of the International Cooperation Administration (ICA) and the Spanish Commission on Productivity, seven chosen scientists of Spain toured ten American cities during September and October 1959 and studied American electroplating, metal finishing and allied arts in plant operation.

The touring team of Spanish electroplating experts included Jose-Maria Alameda, Jose Arce, Rafael Garcia, Venancio Lopez-De-Ceballos, Eduardo Sanchiz, Alberto Sarricolea and Manuel Serra.

The cities visited by the seven Spanish scientists included New York, Boston, Buffalo, Cleveland, Chicago, Detroit, Minneapolis, Cincinnati, Washington and Baltimore. The team departed for Madrid in late October via Iberian Airlines.

CONVENTION PAPER REPRINTS CAN BE PURCHASED IN QUANTITY

The Golden Jubilee Edition of the book, TECHNICAL PROCEEDINGS (1959 Edition) of American Electroplaters Society, Inc. Inc. (AES) has been completed, and copies of that massive treasure chest of knowledge on electroplating, metal finishing and allied arts were issued to members in good standing of the Society as at November 1, 1959, internationally, in late November, a publishing time record. By his AES membership, each such member was entitled to such a free copy. A limited quantity of extra copies is now available for sale to AES non-members on strictly a "first-come, first-served basis" so long as that limited extra quantity lasts. (See advertisement pages 28 and 29).

Not only does the 1959 book contain each of the 43 papers delivered by experts of nine countries before the "Fifth International Conference on Electrodeposition and Metal Finishing," educational sessions arm of the AES's Golden Jubilee Convention held in Detroit, Michigan, June 15–19, 1959 but it also includes the transcript of the discussion that attended the delivery of each such paper.

For those companies or individuals desiring to purchase a quantity of any of the 43 copyrighted papers appearing in that AES book, there is a price list available upon request specifying cost and how to order. Address your request for information to the Production Manager, TECHNICAL PROCEEDINGS, American Electroplaters' Society, Inc., American Building, 443-445 Broad Street, Newark 2, N. J.

TO AES MEMBERS

Each AES member is urged to purchase an official AES lapel pin from his Branch Secretary and proudly wear it. Branch Secretaries may, in turn, purchase such silver pins from AES National Headquarters at the following prices, including tax: Branch Past President's pin, $1.43 per pin, Branch Members pin, $1.38 per pin.

PUBLISHING SPECIFICATIONS FOR PLATING AUTHORS

So as to assist authors interested in submitting manuscripts of original technical, scientific or practical plating papers for publishing consideration by PLATING MAGAZINE, a handy booklet has been prepared titled, "Publishing Specifications for PLATING MAGAZINE Authors."

Papers are considered on the basis of those specifications. A copy of the printed little booklet will gladly be sent to any potential author desiring to submit any such original paper for PLATING evaluation. All PLATING papers accepted and published have, of course, first been favorably considered by three anonymous "reviewers," each qualified on the subject, specifically appointed to consider that particular paper.

LADIES WHO GRACE AES's ACTIVE MEMBERSHIP

Throughout the world, in practically every endeavor, members of the female sex have made noteworthy progress, especially since World War II, in advancing to positions of significance and responsibility. They have made their presence felt by education, ambition and performance. They have been welcomed into the Associations and Societies serving their respective fields of interest—and the American Electroplaters' Society (AES) is among those that has admitted them on generally the same basis of eligibility as applies to acceptance of male AES members.

AES membership stature in AES's various membership classifications fluctuates, of course, from day to day as in other Associations and Societies. As at Autumn 1959, these ladies graced AES active membership:

Baltimore-Washington	Dr. Gwendolyn B. Wood
Blue Ridge	Betty Browder
Boston	Bertha P. Colokathis
Chicago	Eileen C. Drews Irene Modjeska Joan Wiarda
Cleveland	Betty L. Berdon Betty M. Luce Katherine Pawlikowski Marilyn Saniky
Columbus	Mary Fulmer
Dayton	Ilsa W. Kendall
Detroit	Josephine Boatman Jeanne A. Herrmann Ann G. Piken Alice E. Pillsbury
Indianapolis	Jeannette F. Peacock Edna Rohrabaugh
Los Angeles	Marjorie E. Farmer Virginia Herbert
Melbourne	L. Janowska
Mississippi	Marion Hitch
Newark	Petrina De Pietro
New York	Grace Aronson
Seattle-Puget Sound	Helen Archibald
Southeastern	Jerita D. Wilson
Sydney	Mrs. I. B. Coulson
Syracuse	Josephine LeRoy
Toronto	Jean E. Martiquet
Members-at-Large	Marta Acevedo C. Katherine D. Christians Dr. Ir. Clara Henderina de Minjer Jo. S. Shaw

In the preparation of this initial list from among nearly 8,000 AES members, some inadvertance or omission could have occurred. These will be corrected as promptly as discovered.

DETROIT BRANCH HOSTS OUTSTANDING NICKEL PLATING FORUM

Held at Detroit's Statler Hilton Hotel and attended by over 200 AES members and guests of the Detroit Branch, Friday, December 4, with Myron B. Diggin, Vice President of the Hanson-Van Winkle-Munning Company, as Technical Chairman, Detroit's annual "National Officers' Night" featured one of the season's most outstanding educational sessions, namely a forum on nickel plating.

Three of the industry's stars treated that subject, namely Dr. Henry Brown, The Udylite Corp., Walter L. Pinner, McGean Chemical Company and Dr. M. M. Beckwith, Harshaw Chemical Company.

A standout Christmas Party was held the following evening, December 5, with capacity limited to about 800 persons. A well-liked floor show followed the sumptuous dinner.

The Industry's major suppliers joined together to provide a dignified, well-received cocktail party before the dinner and an open house after that repast.

All AES National Officers were present and were welcomed by Branch President Donald M. Bigge and his Executive Group. Leland M. Morse, Chrysler Corporation, was the memorable event's General Chairman.

John B. Tinnon

John B. Tinnon, retired vice president in charge of sales, Metal & Thermit Corporation, died Nov. 30 at New Rochelle Hospital, New Rochelle, New York. He was 74.

A native of Fort Worth, Texas, he was graduated from Vanderbilt University in 1908, where he was a member of Phi Delta Theta. From 1912, he was associated with Chicago and Joliet Electric Railway Company, becoming chief engineer. He served with the U. S. Army during World War I.

In 1924 he joined Metal & Thermit Corporation, New York, and subsequently became sales manager. In 1944 he was elected vice president in charge of sales, which position he held until his retirement in 1955.

PROCTOR AWARD NOMINATIONS DUE BEFORE APRIL 1

Nominating forms are now in the hands of all AES Branches and Standing Committees thereby enabling such Branches and Committees to enter and support any AES member in good standing whom they please in the competition for the Society's new "Charles Henry Proctor Memorial Leadership Award". The new Award is AES's highest non-technical, non-scientific honor and is intended to recognize and reward 1958–1959's most conspicuous administrative, management, public relations or other deed by an AES member enhancing the welfare, dignity or prestige of the AES and its Branches and members.

To be acceptable to the Selection Committee specified in the rules governing the Award, each Branch's or Committee's nomination must be in the hands of the National Executive Secretary on or before April 1, 1960 on the official form provided by National Headquarters, and each such accomplished form must be certified by the AES Branch or Committee as directed thereupon. Each such form *must* be accompanied by seven typed copies of the nominated individual's qualifications for the Award.

The first winner will be announced at the Farewell Banquet of the AES's 47th Annual Convention in Los Angeles on the evening of July 28, 1960. He will receive a $150 cash award, a handsome scroll, and attendant recognition in PLATING MAGAZINE and TECHNICAL PROCEEDINGS. National President Ralph D. Wysong himself heads the Selection Committee which, besides others, also includes the donors, namely Mr. and Mrs. William O. Preston, son-in-law and daughter respectively of the late Charles Henry Proctor, founding father of AES.

SUPREME SOCIETY MINUTES ISSUED BY BOARD IN NEW FORM

At the Annual Meeting of the Supreme Society held in Detroit, June 18, 1959, that AES governing council ordered, in effect, that the Minutes of its (Supreme Society) meeting be issued to each accredited Delegate and Alternate Delegate, and to each Branch President and Secretary, in condensed, standard Minute form prepared by the Board from the official proceedings stenotyped by the Official Convention Reporter, instead of in the voluminous verbatim stenotyped transcript form, as "Business Proceedings", heretofore employed.

The Board having approved its final draft of those Minutes first drafted by Law Committee Chairman Manson Glover, the mimeographed final draft was consequently issued by the Board to all accredited Delegates and Alternates, and to all Branch Presidents and Branch Secretaries, on December 1.

Dr. Hiram S. Lukens

Dr. Lukens, former director of the University of Pennsylvania department of chemistry and chemical engineering, died Wednesday, November 25 at his home, 6 S. Oxford Ave., Ventnor City, N. J. He was 74.

Dr. Lukens retired in 1953 as an emeritus professor of chemistry after 46 years teaching at the university, from which he graduated in 1907 and received his doctorate in 1913.

Starting as an instructor in 1907, he was named professor of chemistry in 1921 and Blanchard professor of chemistry in 1937. He served as director of the chemistry department from 1932 to 1952 and from 1937 to 1938 was also acting dean of the Towne Scientific School at the University.

He served as a civilian consultant to the Federal Government during the First and Second World Wars. He did research in electrochemistry and analytical chemistry and held more than a score of patents.

Very early in the life of the Philadelphia Branch, he showed his interest in aiding platers obtain the additional knowledge of chemistry and electrochemistry, so essential to the proper operation of plating solutions. Through his assistance, the Philadelphia Branch was able to hold its meetings at the Harrison Laboratories of the university, where they were held for more than thirty years, until 1954.

Early, the Philadelphia Branch members recognized the invaluable services given newly organized Branch and Society, and bestowed upon him an Honorary Membership in the Society, which he held for more than forty years. At his passing he was the Branch's only AES Honorary Member.

Dr. Lukens was a former member of the board of managers of the Franklin Institute, a former president of the Electrochemical Society and the University of Pennsylvania chapter of Sigma Xi. He was also a member of the American Chemical Society, the Engineers' Club of Philadelphia, the Chemists Club of New York and the University of Pennsylvania Club of New York.

HOST: AES
PHILADELPHIA BRANCH

INTERIM MEETING REPORTER

BEN FRANKLIN HOTEL
PHILADELPHIA, PA.
FEBRUARY 20, 1960

SEVENTH INTERIM MEETING A FEATURE OF PHILADELPHIA BRANCH'S FIFTIETH ANNIVERSARY

Just as the Commonwealth of Pennsylvania was the second of our nation's original 13 States, so too is AES's Philadelphia Branch the second of the Society's chartered Branches. In that same principal city of America's Keystone State wherein the Articles of Confederation were adopted, where the Declaration of Independence was written and signed, and where the Constitution of the United States was drawn up in our country's long-ago, so too did that so-styled "City of Brotherly Love" serve as locale of the creation of AES's second Branch back in 1910.

And so, on the heels of the AES's year-long, far-flung observance of its GOLDEN JUBILEE in 1959, its Philadelphia Branch will mark its own FIFTIETH ANNIVERSARY in 1960, climaxed by a two-day Anniversary commemorative to be held at the Ben Franklin Hotel, Philadelphia, February 19–20. That celebration will feature two high-quality educational sessions—plus a plant tour, and a fitting banquet, floor show and dance.

Concurrently, the Supreme Society, AES's governing council, will conduct its SEVENTH INTERIM MEETING there on Saturday, February 20—with accredited Branch Delegates from many parts of the United States and Canada expected to be present so as not only to participate in the deliberations of that council but also to share in Philadelphia's celebration of its GOLDEN ANNIVERSARY.

Aside from the Philadelphia Anniversary observance and the Supreme Society's Interim Meeting, the Ben Franklin Hotel will also be site of the AES Research Committee's all-day meeting on February 18 and of the AES Executive Board's all-day regular meeting on February 19, continuing on February 21. It will also house the joint annual meeting of the AES's Executive Board and the Board of Trustees of the Metal Finishing Suppliers' Association (MFSA) to be held in the AES Executive Suite on the evening of February 19. A meeting of the Membership Committee has also been scheduled.

TENTATIVE PROGRAM

FIFTIETH ANNIVERSARY, PHILADELPHIA BRANCH
AND
SEVENTH INTERIM MEETING, SUPREME SOCIETY

BEN FRANKLIN HOTEL, PHILADELPHIA
FEBRUARY 18-21, 1960

THURSDAY, FEBRUARY 18

9:30 a.m.—AES Research Committee Meeting (All Day) ..... Lafayette Room

FRIDAY, FEBRUARY 19

9:00 a.m.—AES Executive Board Meeting (All Day) ..... Executive Suite
10:00 a.m.—Registration, Branch Fiftieth Anniversary ..... Mezzanine Foyer
2:00 p.m.—Plant Tour (Sellersville Plant, American Machine & Metals Co.) Bus Leaves 2 p.m.
6:00 p.m.—Dinner (Dutch Treat) ..... (To be announced)
7:30 p.m.—GRAND OPENING Session, Branch Fiftieth Anniversary ..... Washington Room
8:00 p.m.—Educational Session "A" ..... Washington Room
"Remedies for Corrosion of Nickel Chromium Coatings" by Dr. W. A. Wesley, International Nickel Co.
"Zinc and Cadmium Plating" by John Winters, Incar, Inc.
8:00 p.m.—Joint Meeting, Executive Board, American Electroplaters' Society and Board of Trustees, Metal Finishing Suppliers' Association ..... Executive Suite

SATURDAY, FEBRUARY 20

7:30 a.m.—Breakfast Meeting, AES Membership Committee ..... Robert Morris Room
8:00 a.m.—Registration, Branch Fiftieth Anniversary ..... Mezzanine Foyer
8:00 a.m.—Registration, Delegates-Alternates, AES Supreme Society ..... Mezzanine Foyer
10:00 a.m.—Seventh Interim Meeting, Supreme Society ..... Franklin Suite
10:00 a.m.—Educational Session "B" ..... Betsy Ross Suite
"Hard Anodizing" by Dr. Harold J. Wiesner, Bendix Aviation Co.
"Anodizing and Chemical Finishes" by Russell VandenBerg, Aluminum Company of America
"Plating on Aluminum" by William K. Murray, Enthone, Inc.
1:00 p.m.—Seventh Interim Meeting Luncheon (Dutch Treat) ..... Washington Room
2:00 p.m.—Seventh Interim Meeting, Supreme Society ..... Franklin Suite
6:00 p.m.—Fiftieth Anniversary Cocktail Hour ..... Franklin Suite
7:00 p.m.—Fiftieth Anniversary Banquet and Floor Show ..... Crystal Ballroom

SUNDAY, FEBRUARY 21

9:00 a.m.—AES Executive Board Meeting ..... Executive Suite

AGENDA

SEVENTH INTERIM MEETING AES SUPREME SOCIETY

BEN FRANKLIN HOTEL, PHILADELPHIA, PA.
FEBRUARY 20, 1960

1. Welcome by Philadelphia Branch
2. Welcome by National President and Congratulations to Philadelphia Branch on its Fiftieth Anniversary
3. Opening of the Session as an Interim Meeting
   Purpose of the meeting as a sounding board on matters for subsequent consideration and action by the Supreme Society at its Annual Meeting in Los Angeles, July 28, 1960
4. Progress and Status Reports:
   Financial by President
   Educational by First Vice President
   Membership by Second Vice President
   Branch Regionalization, Regional Annual Meetings and Branch Convention Exhibits as Tools of AES Educational Mission by Third Vice President
   Honorary, Merit and Achievement Awards as Inducements for Greater AES Service by Immediate Past President
   Headquarters and AES Publishing and Public Relations by National Executive Secretary
   AES Research Program by Chairman, Research Committee
5. Preliminary Reports:
   a) Executive Board Appraisal as to AES Investments
   b) Executive Board Recommendations for AES Constitutional and/or Bylaw Amendments If Any
6. Comments and Questions from the Floor:
   a) Membership Promotion (Membership Committee Chairman, Discussion Leader)
   b) Sustaining Member Promotion (Vice Chairman for Finance, Research Committee, Discussion Leader)
   c) Book Publishing (Publications Committee Chairman, Discussion Leader)
   d) Branch Educational Sessions (Chairman, Public Relations Committee, Discussion Leader)
7. AES National Conventions and Interim Meetings
   a) 1960 Los Angeles Convention (Los Angeles Convention General Chairman)
   b) Other AES National Conventions Ahead
   c) Seventh Interim Meeting, Philadelphia (General Chairman)
   d) Eighth Interim Meeting, Hartford (New England Region Representative)
   e) Report of Outcome of Golden Jubilee Convention and Industrial Finishing Exposition, including Fifth International Conference on Electrodeposition and Metal Finishing (Executive Board)
   f) Proposed Dates for AES's Next Industrial Finishing Exposition
8. New Business Brought For Discussion by Delegates
9. Announcement of Candidates for Third Vice Presidency
10. Adjournment

(Top) A Disneyland 105 "horseless carriage" in front of the majestic Sleeping Beauty Castle, entrance to Fantasyland. (Lower) Double-decker oldtime coach loaded with visitors to Disneyland.

CHILDREN'S PROGRAM:

A FEATURE OF

AES's 1960 LOS ANGELES CONVENTION

At the AES's 43rd Annual Convention held in Washington, D. C. in June 1956 under the dynamic leadership of Convention General Chairman Arthur G. Pierdon of AES's Baltimore-Washington host Branch, one of the features was its Children's Program. AES families brought their youngsters to view the nation's capital's bountiful sights and to be educated while having fun and relaxation. They were abundantly rewarded by the results.

Many AES families—taking advantage of the rare opportunity to combine Convention with California holiday—are seemingly planning to bring their children to Los Angeles for AES's first West Coast Convention, July 24-28, 1960. And to make the stay of AES children a never-to-be-forgotten adventure, the Los Angeles Branch Convention Committee headed by Convention General Chairman Tony Stabile is laying impressive plans to fill the Convention hours of AES youth joyfully.

Parents, upon arrival at the Convention, will be able to purchase a Children's Program ticket book (at nominal cost soon to be announced) for each of their youngsters. Tentatively, as this is written, such a ticket book will entitle the youngster to four fun-filled days of specially planned sightseeing and relaxation, including cost of chaperoned transportation and luncheons.

Under the direction of Eugene C. Bosl, Children's Program Chairman, the youngsters, well-escorted and supervised, will be taken by bus on Monday, July 25, to Knott's Berry Farm where the Old West and the days of the '49ers live again in authentic atmosphere—then, following lunch, to California's Marineland, known as the world's most spectacular circus of marine life.

On Tuesday, July 26, they will join their elders at the AES outing to renowned Disneyland.

On Wednesday, July 27, transported by bus, they will sightsee, well-chaperoned—including a tentatively planned tour of a motion picture studio.

And on Thursday, July 28, they will experience the thrills of Western ranch life by visiting either Crash Corrigan's "Corriganville" or the ranch layout of Gene Autry.

Parents, if they please, can also purchase Thursday night banquet tickets for their children at fixed banquet price.

So plan to bring YOUR children to America's "Wonder City" for AES's 47th Annual Convention. YOU'LL BE SO GLAD YOU DID!

SOME OF DISNEYLAND'S FABULOUS ATTRACTIONS

(Left) Main Street of Walt Disney's magic kingdom—Disneyland—thrilling to young and old alike. (Center) The Mark Twain, Mississippi River Boat replete with brass band and all of the nostalgia of a by-gone day, approaches Settler's Landing. (Right) Town Square of Disneyland, replica of an earlier day, with its City Hall, Fire House, Emporium and buildings and sights that have faded or are fast fading from the American scene.

CONVENTION CHAIRMEN

Mrs. Glen J. Beckwith
Ladies

Tony Stabile
Chairman

George J. Hetz
Vice Chairman

Walter P. Behlendorf
Finance

Lawrence M. Henderson
Hotel

L. Truman Stoner
Outing

Harvey K. Hunt
Plant Visits

E. W. Wells
Publicity

C. Phillip Simon
Registration

Lawrence O'Neil
Entertainment

Eugene Bosl
Children

John D. Millhorn
Program

Earl W. Arnold
Educational Sessions

G. Stuart Krentel
Printing

Mrs. Alice M. Prescott
Secretary

William P. Thomas
Banquet

Norman F. Painter
Housing

THE 47TH ANNUAL CONVENTION
AMERICAN ELECTROPLATERS' SOCIETY, INC.
STATLER HOTEL, LOS ANGELES, CALIFORNIA
JULY 24-28, 1960

SPONSORSHIP: American Electroplaters' Society, Inc.
American Building
443–445 Broad Street
Newark 2, N. J.

HOST BRANCH: AES Los Angeles Branch

LEADERSHIP: Tony Stabile, General Chairman
Associated Plating Company
417 East Sixteenth Street
Los Angeles, California

George J. Hetz, Co-Chairman
C & W Metal Finishing, Inc.
3525 S. Greenwood Avenue
Los Angeles, California

LADIES PROGRAM: Mrs. Glen J. Beckwith
13231 Ethelbee Way
Santa Ana, California

CHILDRENS PROGRAM: E. C. Bosl
Alert Supply Company
2041 South Davie Avenue
Los Angeles 22, California

Educational Sessions . Plant Visits . Outing . Guided Tours
Entertainment . Banquet . Dancing . Floor Show

TENTATIVE PROGRAM

This is a TENTATIVE PROGRAM as of December 31, 1959. Additions and modifications will be made monthly until finalized.

SUNDAY, JULY 24

9:00 a. m.	Executive Board Meeting (All Day)	Dallas Room (Hq. Room)
2:00 p. m.	Honorary Membership Award Committee Meeting	Washington Room
2:00 p. m.	Scientific Achievement Award Committee Meeting	St. Louis Room
3:00–5:00 p. m.	Ladies Program. California Welcome Tea	(To be Announced)
4:00 p. m.	Credentials Committee Meeting with Executive Board	Dallas Room
8:00 p. m.	Get-Together Party	(To be Announced)

MONDAY, JULY 25

9:00 a. m.	Children's Program—Supervised Visit to Marineland and Knott's Berry Farm (subject to change)	(Bus time to be Announced)
10:00 a. m.	Grand Opening Session	Golden State Room
11:00 a. m.	Business Meeting, Supreme Society	Golden State Room
12:00 noon	Branch Secretaries' Luncheon	New York Room
12:00 noon	Ladies Program. Luncheon and Entertainment	(To be Announced)
12:15 p. m.	Speakers' Luncheon	Cleveland Room
2:00 p. m.	Educational Opening Session Second Annual "William Blum Lecture" (Dr. A. Kenneth Graham, Second Winner, "AES Scientific Achievement Award".)	(To be Announced)
2:00 p. m.	Plant Inspection Trip	(To be Announced)
2:30 p. m.	Editorial Board Meeting	Boston Room
2:30 p. m.	Educational Session A "Statistical Analyses Applied to Plating Processes" "Metal Finishes and Problems in the Missile Field" "Safety in the Plating Room"	(To be Announced)
2:30 p. m.	Educational Session B Organic Coating (Papers to be Announced)	(To be Announced)
4:00 p. m.	Order of Past Presidents' Business Meeting	Detroit Room
6:30 p. m.	Order of Past Presidents' Dinner	Washington Room
8:00 p. m.	Open House (Sponsored by Metal Finishing Suppliers' Association)	(To be Announced)

TUESDAY, JULY 26

8:00 a. m.	Charles Henry Proctor Memorial Leadership Award Selection Committee Breakfast	(To be Announced)
8:00 a. m.	Speakers' Breakfast	Cleveland Room
9:00 a. m.	Membership Committee Meeting	(To be Announced)
9:00 a. m.	Public Relations Committee Meeting	Detroit Room
9:00 a. m.	Educational Session C "Recent Developments in Gold Electroplating" "Thick Gold Deposits" "Acid Gold Plating" "Precious Metal Plating in Printed Circuits"	(To be Announced)
9:00 a. m.	Educational Session D "Outdoor and Accelerated Corrosion Test Comparisons" "Corrosion Resistance Progress Reports" "New Procedures for Plating Zinc Diecastings" "Effects of Variation in Copper Plating on Corrosion Performance"	(To be Announced)
1:00 p. m.	Annual Outing	Disneyland

WEDNESDAY, JULY 27

8:00 a. m.	Research Committee Breakfast	Cleveland Room
8:00 a. m.	Speakers' Breakfast	Buffalo Room
9:00 a. m.	Educational Session E—"Hydrogen Embrittlement in Metal Finishing" Symposium (Papers to be announced)	(To be Announced)
9:00 a. m.	Research Committee Meeting	Detroit Room
9:00 a. m.	Publications Committee Meeting	Boston Room
9:00 a. m.	Educational Committee Meeting	Washington Room
9:00 a. m.	Children's Program—Supervised bus view of "Homes of the Stars" and guided tour, motion picture studio (subject to change)	(Bus time to be Announced)
12:00 noon	Joint Educational Committee and Branch Librarians' Luncheon	New York Room
12:00 noon	Speakers' Luncheon	Buffalo Room
12:30 p. m.	Ladies' Program "Luncheon Around the Aqua Pool" and California Fashion Show	Beverly Hilton Hotel
2:00 p. m.	Research Committee Meeting	Detroit Room
2:00 p. m.	Educational Session F—"Hydrogen Embrittlement in Metal Finishing" Symposium (Papers to be announced)	(To be Announced)
7:30 p. m.	Round Table Discussion on "Hydrogen Embrittlement in Metal Finishing"	(To be Announced)
9:30 p. m.	Floor Show and Dance	Pacific & Sierra Rooms

THURSDAY, JULY 28

8:00 a. m.	Speakers' Breakfast	St. Louis Room
9:00 a. m.	Ladies' Program. TV Show and Breakfast in Hollywood	(Bus time to be Announced)
9:00 a. m.	Business Meeting, Supreme Society	Sierra Room
9:00 a. m.	Educational Session G "A Study of Variation in Certain Characteristics of Bright Nickel Deposits with Variation in Bath Temperature" "Magnetic Properties of Electrodeposited Cobalt Alloys" "Sulfamate Plating Solutions of Cobalt, Iron and Cadmium" "Electroless Nickel"	(To be Announced)
9:00 a. m.	Educational Session H "Cleaning Techniques in Electronics Industry" "Study of Anodic Coatings on Aluminum" "Solution Transfer in Plating Barrels" "New Method of Chrome Plating Directly on Aluminum"	(To be Announced)
9:00 a. m.	Children's Program—Supervised visit of Corriganville or Gene Autry Ranch (Subject to change)	(Bus time to be Announced)
9:30 a. m.	Plant Inspection Trip	(To be Announced)
11:00 a. m.	Ladies' Program. Bus View of "Homes of the Stars"	(Bus time to be Announced)
12:30 p. m.	Ladies' Luncheon (Dutch Treat) and Shopping, Farmer's Market	Farmer's Market
1:00 p. m.	Plant Inspection Trip	(To be Announced)
2:00 p. m.	Business Meeting, Supreme Society	Sierra Room
2:00 p. m.	Educational Session I "AES Research and Its Seven Active Projects" "Corrosion Problems with Decorative Chrome" "Dual Chrome Systems" "Chrome Plating Rifle Barrels"	(To be Announced)
7:00 p. m.	Annual Banquet and Dance	Pacific & Sierra Rooms

FRIDAY, JULY 29

8:00 a. m.	President's Breakfast to National Officers & Families	AES Executive Suite
9:00 a. m.	Executive Board Meeting	Dallas Room

INTERSOCIETY NEWS

SPE MEETING TO HIGHLIGHT PLASTICS IN AUTOMOTIVE AND APPLIANCE INDUSTRIES

Papers of special interest to design and production engineers in the automotive and appliance industries will be presented at the 16th National ANTEC Meeting of the Society of Plastics Engineers, Jan. 12–16, Conrad Hilton Hotel, Chicago. Every phase of manufacture will be covered in special sessions devoted to individual materials and problems.

"Few industries have enjoyed the phenomenal growth of the plastics industry during the past decade," says Franklin L. Fine, SPE 16th ANTEC General Chairman. "In this rapidly-expanding field, there are few opportunities such as that presented by this once-a-year meeting of the Society of Plastics Engineers", adds Mr. Fine. "Important new developments, experiental processes, and methods of evaluating and processing present-day plastics are thoroughly covered in the 82 papers to be presented and discussions that follow."

ISA FIRST 1960 CONFERENCE IN HOUSTON

The Houston (Texas) Section of the Instrument Society of America will act as host to the first of ISA's three Instrument-Automation Conferences and Exhibits scheduled for 1960. The Conference sessions will be held Feb. 1–4 at the Rice Hotel, while the Exhibit will be staged in the Sam Houston Coliseum, Feb. 2–4.

In outlining plans for the Winter Conference and Exhibit, John Johnston Jr., President of ISA, said there will be 22 technical sessions at the Conference at which more than 60 papers will be presented. The Exhibit, which will occupy some 25,000 square feet in the Coliseum, will be devoted to display and demonstration of the newest products of the nation's leading instrument manufacturers and their representatives.

Since the American Chemical Society's Houston Section will take an active part in the ISA Conference, papers will also be presented by ACS members on analytical laboratory instruments.

Decision to expand its Conference and Exhibit services to three major areas during 1960, rather than confining it to one nationwide conference, was reached by ISA because of the tremendous and rapid advancement and growth of instrumentation and automation in all parts of the nation. It was felt that time and expense could best be conserved by holding three Conferences and Exhibits during 1960, the first in Houston, Feb. 1–4; the second in San Francisco, May 9–12, while the International Conference and Exhibit would be held in conjunction with ISA's 15th annual member's meeting in New York City, Sept. 26–30.

Formed in 1946, ISA today is the acknowledged spokesman for the growing profession of instrument engineering and application. With more than 12,000 members, and some 96 local Sections in the United States and Canada, ISA through its services and activities embraces the whole field of instrumentation.

ASTM HOLDS BIG TECHNICAL PROGRAM AT SAN FRANCISCO, CALIF.

The American Society for Testing Materials 3rd Pacific Area National Meeting in San Francisco, October 12–16. emphasized in many sessions the extreme environments which materials are now required to withstand in an age of rockets, jets, missiles, re-entry nose cones, atomic power plants, and high-temperature industrial uses; other sessions were directing attention to far different but no less important problems of materials for our nation's airports, highways, dams, industrial plants, homes, and waterfront structures. Other groups concerned themselves with radiation, spectroscopy as an analytical tool, utilization and disposal of industrial water, air pollution control, and other equally urgent problems. The 2nd Nuclear Problems Forum provided industry with a chance to trade views and be brought up to date on what the Society's committees are doing in this important field.

Highlight of the week was the President's National Luncheon honoring Frank L. LaQue, at which Lieut. Gen. Bernard A. Schriever was the guest speaker. President LaQue's remarks which he entitled "ASTM Materials and Progress" emphasized the theme that progress depends on advances in materials.

A tape-recorded message from the Society's executive secretary, Robert J. Painter, who was continuing his convalescence at Chestnut Hill Hospital, realistically welcomed the guests and visitors.

General Schriever, Commander of the Air Research and Development Command, in his address entitled "Materials in the Aerospace Age" underscored the Air Force's heavy dependence on the perfection of new materials in everything from conventional aircraft to rocket motors and re-entry cones.

Fifteen technical committees and their subcommittees held a total of almost 200 meetings getting their work under way for the coming year. The 52 technical sessions with five or six running concurrently throughout the week drew many visitors from the East as well as from the western states. Although total attendance at the meeting didn't quite reach the early estimates, more than 1300 registered during the week—619 members, 187 committee members, and 495 visitors.

The plant visits were organized by a special committee of San Francisco area members. The most popular trip was that to the General Electric Co., Vallecitos Atomic Laboratory, for research and development on atomic products and the site of the General Electric—Pacific Gas and Electric Co.'s Atomic Power Plant which holds AEC License No. 1.

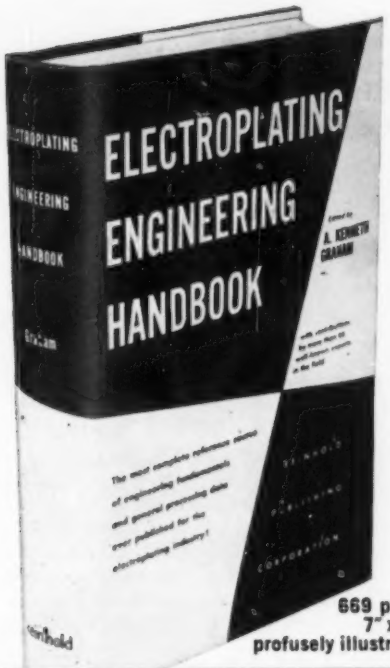
Newer Metals Symposium

The demands for metals in the new environments of nuclear radiation, extreme temperatures, and extreme stress conditions, coupled with the need for high reliability in these applications has pushed development of the so-called "newer metals." A Symposium on Newer Metals was held during the ASTM Pacific Area meeting to gather information that the Society could use in writing specifications.

Westinghouse Electric Corp. described a universal high-temperature testing machine for vacuum or controlled atmospheres designed for either constant strain-rate testing or for stress-rupture testing at constant load. Capacities: a maximum test temperature of 3000C, maximum load of 5000 lb, and head motion from 0.002 to 2 in. per hr.

Other papers described the mechanical properties of molybdenum and molybdenum alloy sheet (Climax Molybdenum Co.), creep properties of beryllium (Brush Beryllium Co.), fabrication procedures for columbium and tantalum (Universal-Cyclops Steel Corp.), and high-temperature mechanical properties of tantalum (Battelle Memorial Institute and The Martin Co.). Other metals discussed included the platinum group (ruthenium, rhodium, palladium, iridium, and platinum), zirconium and its alloys, yttrium and its alloys, chromium, tungsten, and lithium.

ASTM task groups under Subcommittee VIII of Committee B-2 on Non-Ferrous Metals and Alloys are working on most of these metals.



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Here are a few excerpts from a review in *Research and Engineering:* "The book is very well written, remarkably free from typographical errors, and shows an excellent appreciation of the problems encountered by the practitioner in the selection of tables and topics covered . . . much attention is paid to definition of all terms used, and it appears that special attention must have been directed toward making each presentation easy to understand . . . The editor and his associates are to be complimented on a fine job, resulting in a volume which may be recommended to all who are associated with the engineering aspects of electroplating."

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INDUSTRY NEWS

SEL-REX CORPORATION BUYS THE MEAKER COMPANY

The Meaker Company, Chicago, Illinois, pioneer manufacturer of automatic systems for continuous and batch metal processing or finishing since 1899, has been purchased by Sel-Rex Corporation, it has been announced. According to Morris M. Messing, president of Sel-Rex, The Meaker Company will operate as a wholly-owned subsidiary, under the general supervision of its present staff.

Morris M. Messing

Officers and executive personnel of The Meaker Company, as reorganized, will be: Morris M. Messing, President; Victor Finston, Executive Vice President and General Manager; Alexander Wright, Administrative Vice President; and Lucien R. Collart, Secretary-Treasurer. Jerome L. Ross, formerly Manager of Sel-Rex's Equipment Division, has been appointed Assistant General Manager and will make his headquarters at the Meaker Offices at 1629–41 South 55th Avenue, in Chicago.

According to the announcement, The Meaker Company facilities for manufacturing, engineering, sales and service will be expanded to diversify current product lines, as well as to intensify marketing operations of the automatic equipment for which The Meaker Company has been known since 1899.

It is reported that present distributor-franchises will be renewed, and that several new resident Sales and Service Engineers will be appointed shortly to provide more concentrated coverage for the entire country.

The Meaker Company designed and built some of the largest fully automatic metal processing and plating machines in the world. One relatively recent installation—currently the greatest production equipment of its kind on record—for the plating of automobile bumpers, produces over four acres of plated surface every 16 hours. The steel used in the fabrication of this equipment is said to equal that used in a 38-story office building with an area of 10,000 square feet per floor, and covers 180,000 square feet—the equal of 4 football fields.

With the acquisition of The Meaker Company, and the greatly expanded and varied line of products for metal finishing and processing, Sel-Rex is expected to play an even more important role in the industries it serves.

ALLIED RESEARCH HOLDS REGIONAL SALES MEETINGS

Allied Research Products, Inc., Baltimore held three-part series of fall regional sales meetings.

The first meeting, comprising the Northeast Region under the direction of L. F. Richard, was held Oct. 7–9 at Pocono Manor, Mt. Pocono, Pa. This was followed by a gathering of the representatives covering the Central District, under the direction of L. J. Camill, at the St. Clair Inn, St. Clair, Michigan, Oct. 14–16. The concluding session of the series was held at Lake Lawn Lodge, Lake Delavan, Wisconsin, Oct. 21–23. Representatives from the Midwest territory, under the direction of A. L. Poe, attended this session.

Members of the headquarters staff attending the meetings included H. C. Irvin, president; J. A. Cairns, vice president in charge of sales, and F. M. Mansfield, vice president in charge of marketing.

Also tied in with the series was an equipment specialists training course held at Allied's Detroit offices during latter September.

COWLES CHEMICAL SALES PERSONNEL TO ATTEND MANAGEMENT INSTITUTE

The Cowles Chemical Company, Cleveland manufacturer of industrial chemicals, is the first company to enroll sales personnel in the Field Sales Management Institute to be held at the Sheraton-Cleveland Hotel, Feb. 15 to 19, 1960, under the joint sponsorship of the National Sales Executives International, the Sales Executives' Club of Cleveland and 24 other affiliated sales executives' clubs in the east-central region.

The Field Sales Management Institute is one of five integrated sales development programs sponsored by the National Sales Executives International, an organization of over thirty thousand sales executives throughout the world.

This program, which has received the enthusiastic endorsement of outstanding companies throughout the country during the past three years, is being held in Cleveland for the first time. The Sales Executives' Club of Cleveland has made this five-day program available to companies in the east-central region through their efforts as a co-sponsor with the national organizations.

ANACHROME OPENS NEW ARIZONA PLANT

Anachrome Corp., affiliate company of Anadite, Inc., South Gate, California, announces the opening of their new Arizona Division located in Tucson. The new division is geared to produce hard anodizing for the electronic and missile industries in the Tucson-Phoenix-Fort Huachaca area. A major portion of the new plants' production program will be devoted to the creation of hard anodized coatings on strategic aluminum parts used in electronics. The new division was established to give the new and rapidly growing electronic and missile industries of Arizona a local source for hard anodizing.

The Hardas Process, a hard anodizing process recently developed for use in the electronic industry, will be used extensively on parts where dielectric strength and thermalconductance are required.

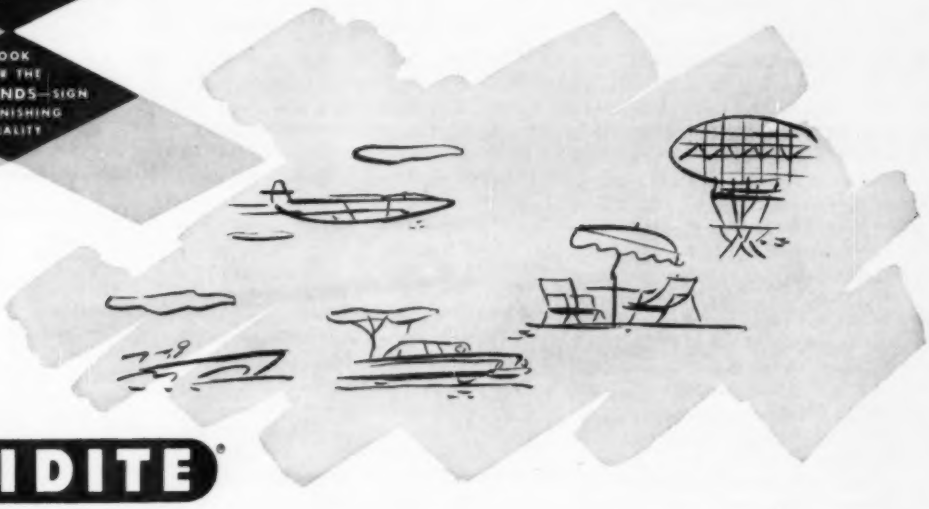
DIAMOND ALKALI ANNOUNCES EDUCATIONAL AID PROGRAM

The Diamond Alkali Foundation has announced the establishment of a new, four-fold program designed to financially assist higher education in this country. The program, which becomes effective January 1, 1960, includes direct financial grants to colleges, merit scholarship awards, graduate fellowships, and for the first time, an employe gift matching plan.

A significant part of the total contribution will be allocated for the Educational Grants Program. Schools whose scientific curricula include courses beneficial to the chemical industry will receive the grants directly, to be administered at their discretion.

Under the Merit Scholarship Program, the foundation will award two four-year scholarships to students whose intended course of study pertains to the chemical industry. Finalists in the testing competitions of the National Merit Scholarship Corporation will be selected, with preference given to sons and daughters of Diamond employes.

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY



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IRIDITE—a specialized line of chromate conversion coatings for non-ferrous metals. Apply by dip, brush or spray methods — at room temperature — manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. No special equipment, exhaust systems or specially trained personnel required.

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FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 130.

ATLAS POWDER DEDICATES NEW LABORATORY

Atlas Powder Co. dedicated its new Darco Experimental Laboratory in Marshall, Tex., during a week-long observance of "Atlas Appreciation Days" initiated by the East Texas community in honor of the company's 38 years of operation there.

A feature of the dedication and "Salute" in mid-October was a tour, for families of employes and for the general public, of the new laboratory and of the company's newly modernized activated carbon plant. Several Atlas officials from Wilmington and others from the local plant and laboratory had a part in most of the week's events, which included a 52-page special edition of the *Marshall News Messenger*, devoted to information about Atlas, its products, and its people; 6 major speeches by Atlas people before each of the community's service clubs; 18 displays set up in windows of downtown businesses; and a reception and dinner by the Marshall Chamber of Commence, sponsor of the "Salute."

SAPORITO PLATING OPENS NEW PLANT

A totally new custom plating plant, stated by C. J. Saporito, president, to be the largest in the Chicago area, has been put into operation by the C. J. Saporito Plating Company, at 1803 S. Fifty-fifth Avenue, Chicago 50, Illinois.

When all plating equipment is in operation, this plant draws more electric power than the average requirement for a city of several thousand persons.

Precious metal plating of finishes such as gold, silver, paladium, rhodium, and others, to meet the rigid government specifications for nuclear and electronic equipment parts is done in a separate department.

For mass production customers, there have been installed continuous process, automated platers, including a patented hard coat, aluminum anodizing process developed by the company.

INTERNATIONAL DIVISION AND MEXICAN PLANT FOR METAL AND THERMIT

Establishment of a new International Division to increase the rate of growth of Metal & Thermit Corp's. operations overseas has been announced by H. E. Martin, president. Simultaneously, he also announced construction of an M&T manufacturing facility in Mexico.

According to Mr. Martin, the new division will be headed by Charles H. Carpenter Jr., as general manager. He was formerly manager of the company's Commercial Development Division.

The new International Division will consolidate responsibility for company operations and sales in foreign countries. It also will handle licensing and patent agreements, and will provide liaison with M&T foreign subsidiaries and affiliates—with the exception of Canadian interests and Australian mining operations.

SEL-REX LICENSES WILDBERG BROS. TO MAKE AND SELL PATENTED PRECIOUS METALS PROCESSES

Wildberg Bros. Smelting & Refining Co., San Francisco and Los Angeles, California, has been licensed to manufacture and sell alkaline and acid gold plating formulations covered by various Sel-Rex Corp. patents, it has been announced jointly by both companies. It is reported that Wilberg Bros. Smelting & Refining Co. will announce shortly their offering of several new gold plating processes, as well as the continued availability of Wilbro "Bright Gold," operating under this licensing agreement.

Walter T. Haley, vice president and general manager of Wildberg Bros. Smelting & Refining Co., reports that technical personnel from his company have already completed a training program at the Sel-Rex laboratories in Nutley, N. J.

According to Morris M. Messing, president of Sel-Rex, the licensing agreement does not affect the operation of their West Coast office.

BOOKS

Remittance must accompany all book orders placed with AES Headquarters.

Corrosion Prevention, Office of the Chief of Civil Engineers, Bureau of Yards and Docks, U. S. Navy, December 1956, 431 pages. (Order PB 151756 direct from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C., $6.00.)

This manual on corrosion prevention prepared by the U. S. Navy's Bureau of Yards and Docks for its personnel engaged in construction, operation, and maintenance of naval shore facilities now has been published for sale to industry.

Data are assembled on atmospheric, submerged, and subsurface corrosion, and corrosion on areas alternately wet and dry. What the Navy has found to be the most practicable methods and materials for controlling or minimizing corrosion are described in detail.

Among corrosion processes discussed are those caused by use of dissimilar metals, with particular emphasis on the Electromotive Force Series and galvanic corrosion, direct chemical attack, stray current, microbiological and atmospheric attack, and marine corrosion.

Such methods of corrosion control are outlined as the use of nonmetallic materials and coatings, claddings, and coverings; passivity; change of environment to reduce exposure to corrosion through the use of passivators or inhibitors, underground backfills, and combinations of zinc and iron in hot water facilities.

One section presents a selection of material combinations and a selection of metals with a discussion of polarization; another gives a complete discussion on cathodic protection and electrochemical processes.

Finishing Engineering Co., Erie, Penna., makers of decorating equipment, have just moved into their new plant with more than twice the floor space (26,000 sq ft) of their previous building, and 4½ acres of ground for further expansion. Founded only eight years ago by Robert B. Way and Carl Hersey, the firm has grown rapidly in the design and production of spray masks, vacuum plating racks, spray and paint wiping machines, and related equipment.

INDICATE A 131. ➤

LEA

ABRASIVE FINISHING METHODS

SILVER SOLID AND ALLOYS

STAMPINGS • SPINNINGS • CASTINGS

Of the noble metals silver is by far the most widely encountered in the metal finishing field. It is seldom used in the pure state but mainly in an alloy, such as sterling silver and, to a lesser degree, coin silver. As is commonly realized, the alloying elements, principally copper, are used to increase hardness and wear-resistance.

Because of the relatively high value of the metal, greater care is justified in devising the proper Lea Methods to see that metal losses in the finishing operations are kept to a minimum. The much higher price obtained for sterling silver articles justifies the greater finishing care.

Plated Silver, certainly an important subject, is discussed separately.

Following are the more widely used finishes for sterling and coin silver together with suggestions for producing them:

HAMMERED FINISH... Formerly, much silver was hammer-finished in order to refine the surface and because the alloys could be shaped readily by this method. The method is still used extensively, especially on reproductions. With hammering, of course, no silver is removed by abrasion.

DULL MATTE FINISH... With this finish, as well as with all the following finishes, the metal is first conditioned by "washing out" the pits by either spot sand bobbing or flexible polishing with **Grade "C" or Grade "B-31" Lea Compound** on leather or felt bobs. This step is usually followed by cut-down buffing with a Tripoli composition such as **Grade 765 Learok** and then by brushing at low speed with a suitable mixture of pumice and water.

DULL SATIN FINISH... Proceed as with the dull matte finishing up to but not through the pumice and water step. At that point, follow with a buffing step using **Grade "C" or Grade "B-31" Lea Compound,** whichever is better, at a speed of about 5000 sfm.

BUTLER FINISH, SEMI-BRIGHT TO BRIGHT... Follow the steps given under dull matte finish up to and including the **Grade 765 Learok** cut-down. Then proceed with the final finishing operations, using **Fine Silver grades of Lea Compound,** such as **Grades MH, B12 or 5023,** to give the desired butler finish. Full-disc or packed muslin buffs are used at 7000 to 7500 sfm.

SEMI-MIRROR FINISH... Proceed as with the dull matte finish, through the **Grade 765 Learok** cut-down step. Then follow with coloring, using either **Grade 302-C or Grade 884 Learok** on a loose muslin buff at 7500 sfm.

Where automatic buffing is being done **Grade TH52P Lea Liquabrade** is used for a cut-down operation and **Grade UH20A Liquabrade** for coloring.

MIRROR FINISH... Proceed as with the semi-mirror finish except use **Lea Red Rouge A100 Bar Compound** or **Grade 63LR Liquid Rouge.**

ULTRA-MIRROR FINISH... Proceed as with the mirror finish and follow with lamp black and kerosene.

Burring, Buffing, Polishing, Lapping, Plating and Spray Finishing ... Manufacturers and Specialists in the Development of Production Methods, Equipment and Compositions. Manufacturers of Lea Compound and Learok ... Industry's quality buffing and polishing compounds for over 30 years.

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Lea-Ronal, Inc., Main Office and Laboratory: 139-20 109th Ave., Jamaica 35, N. Y.
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Brass Plating

The Lea-Ronal Brass-Glo* process provides:

- ✔ High rate of deposition
- ✔ Simple operation — constant color

The inherent values of the Lea-Ronal Brass-Glo process have been completely substantiated by results of several years of full production use in numerous plants. Here are some of these values in addition to the two noted above:

- ***Uniformly lustrous deposits over wide current density range (5-100 amperes/ sq. ft. Hull Cell, depending upon agitation rate).***
- ***High cathode efficiency (90% or better).***
- ***Soft, ductile deposits; easily buffed or flowed, if desired.***
- ***Increased production without increasing volume of solution, number of tanks or other expensive equipment.***

By using the Lea-Ronal Brass-Glo process, existing tanks can be made to produce more and better finished pieces. For the new plant, or for an expansion program, less floor space and less capital expenditure will be required to 'set up'.

Just ask any user of this Lea-Ronal Brass-Glo Process or ask to have one of our representatives demonstrate its values in your plant on your products. Most existing solutions can be readily converted.

Our experienced Technical Service is available for any plating problem. Lea-Ronal Plating Formulations and Additives cover practically all plating operations.

* Patents pending.

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Plating Polishing Buffing
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Lea-Ronal Inc.

Are you interested in Buffing, Polishing and Burring Specialties? SEE OTHER SIDE OF THIS INSERT.

INDUSTRY NEWS BRIEFS

KELITE OBTAINS INFRINGEMENT JUDGMENT

The United States District Court, Northern District of Illinois, Eastern Division, on Sept. 15, 1959 ordered, adjudged and decreed that Kelite Corporation recover from defendant, Khem Chemicals, Inc., Steven Karas, Terell W. Fondren, Harlan S. Walkup, Ralph M. Johnson and Lawrence S. Dwyer, jointly, damages in the amount of $90,000.00. This is the result of legal action brought by Kelite Corporation against defendant Khem Chemicals, Inc. for infringement of United States Letters Patent 2,381,124 and wrongful misappropriation of trade secrets.

SAN FRANCISCO BAY FIRM PURCHASED

William J. Saunders, Los Angeles industrialist, has acquired controlling interest in Hardco of California Inc., metal finishers of Berkeley and San Carlos, California, and has become that firm's president and chairman of the board of directors.

With two facilities in the Bay area, Hardco is one of the leading firms of its type in Northern California. The general offices and plant no. 1 are located at 1235 Fifth St., Berkeley. Plant no. 2 is located at 1015 Terminal Way, San Carlos.

NEW GRADING STANDARD FOR COATED ABRASIVE PRODUCTS

Printed copies of a new Commercial Standard for grading of abrasive grain on coated abrasive products are now on sale at the Government Printing Office, according to the Commodity Standards Division, Office of Technical Services, U. S. Department of Commerce.

The standard was requested by the Coated Abrasive Manufacturers' Institute and was recently established by the voluntary endorsements of individual producers, distributors, users and testing laboratories. It designates nationally recognized grading limits for the various sizes of mineral grits used in the production of coated abrasive sheets, belts, discs, rolls, and similar products.

Uniform procedures for recovering the grain from the coated product and for testing it to determine conformity with the grading limits set by the standard are also provided.

Copies of Commercial Standard CS217-59, Grading of Abrasive Grain on Coated Abrasive Products, are available for 15 cents each from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

GOVERNMENT SEEKS QUALIFIED SCIENTISTS

The Civil Service Commission is searching for qualified scientists in the fields of chemistry, mathematics, metallurgy, and physics for research work in various Federal establishments in the Washington, D. C. area. Persons appointed will work with some of the nation's foremost scientists in attractive and promising assignments and will have outstanding opportunities for advancement. The entrance salaries range from $4,490 to $12,770 a year.

Most appointments are made to National Bureau of Standards, Department of the Air Force, Diamond Ordnance Fuze Laboratories, Geological Survey, Bureau of Mines, Food and Drug Administration, and other agencies. The research laboratories in these agencies are among the finest equipped in the world. The basic and applied research being done is highly diversified and affords many challenges in the field of physical science.

Further information regarding these positions is contained in Civil Service Announcements 209B and 210B. The announcements and application forms may be obtained at many post offices throughout the country, or from the U. S. Civil Service Commission, Washington 25, D. C. Applications will be accepted by the Board of U. S. Civil Service Examiners, National Bureau of Standards, Washington 25, D. C., until further notice.

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for NICKEL PLATING

DIRECTLY on ZINC DIECASTINGS, Aluminum, Brass, Copper, Lead Iron.

TREMENDOUS THROWING POWER, COVERS SMOOTHLY parts made up of several metals.

for HARD CHROMIUM

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Harder CRACK FREE deposits. Increased throwing power. Less sensitivity to sulfate content. Exceptionally fine results plating anything calling for Decorative or Hard Chrome.

ZIALITE CORPORATION

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NEW! *defies chemical attack, heat*

"in tank" PUMP and outside FILTER

with detachable

FILTER CHAMBER

Model UAL-20 200-300 Gals./Hr. other models from 50-1200 Gals./Hr.

Compact, takes little space in tank

It's corrosion proof . . . handles all acids and alkaline solutions up to 250°. Self-priming, leakproof EPOXY sump pump provides continuous duty performance. Bracketed inside the tank, it requires no floor space. Outside bracket supports High Temp. Lucite or Epoxy filter chamber . . . ½ or ¾ HP motor. Pump and filter chambers are available separately.

For complete details: WRITE for Spec. Sheet No. 751B

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USE READER SERVICE CARD; INDICATE A 134.

"For that Finishing Touch"

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chromate conversion coatings for zinc, cadmium, copper, brass, bronze and aluminum. Now available in dyed colors as well as clear, irridescent, golden or olive drab. Supplied in liquids or powders.

Write for literature, send samples for treatment or give us your problems — our laboratory staff is available to help solve them.

A new folder describing the full line of black oxide finishes, chromate finishes, cleaners, oils, and strippers is yours for the asking.

HEATBATH CORPORATION
SPRINGFIELD 1, MASS.
or 701 North Sangamon Street, Chicago 22, Illinois

36 Years of Service to the Heat Treating and Metal Finishing Industry

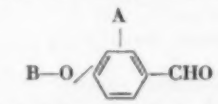
PATENT ABSTRACTS

DR. D. GARDNER FOULKE
SEL-REX CORPORATION
Nutley, New Jersey

Copies of patents may be obtained by writing to Commissioner of Patents, Washington, D. C. Price 25 cents each.

No. 2,885,330, 5/5/59—Bright Zinc or Cadmium Plating—J. Levy, assignor to Trubek Laboratories, E. Rutherford, N. J.

A brightener for zinc and cadmium baths is described as a formyl substituted phenyl ether of the formula:



where A is hydrogen on lower alkoxy radicals and B a hydroxy alkyl radical.

18 claims.

No. 2,885,331, 5/5/59—Copper Plating—H. McLeod and D. Swalheim, assignors to E. I. du Pont de Nemours and Co., Wilmington, Del.

In depositing bright copper from cyanide baths containing hexavalent chromium, the use of less than 1000 ppm of stannous tin ions in the bath is claimed.

1 claim.

No. 2,885,834, 5/12/59—Buffing Wheel—A. Rock, assignor to F. L. and J. C. Codman, Rockland, Mass.

A buff claimed to be equivalent to a ruffled buff but with finger buff advantages is claimed.

5 claims, 9 figures.

No. 2,886,465, 5/12/59—Tinning Oil—J. Nelson, assignor to Sinclair Refining Co., New York, N. Y.

An oil claimed useful for tin plate consists of palm oil to which pentatriacontenyl succinic acid anhydride is added.

claim.

No. 2,886,468, 5/12/59—Nickel Plating—T. Hoover and T. Zava, assignors to USA (AEC).

Contact a surface with a mixture of 5–40 per cent nickel carbonyl, 0.2 per cent H_2S, 1 per cent oxygen and the rest an inert gas.

5 claims.

No. 2,886,469, 5/12/59—Coating Metallic Bodies with Aluminum—E. Fitzer, assignor to Siemens-Planiawerke A.G., Augsburg, Germany.

Claim 1 reads: "A method of coating metallic bodies with aluminum alloys, comprising the following steps, namely, reacting with aluminum, at temperatures within the range from above 500C to above 900C., metallic chloride selected from the class of chlorides consisting of silicon tetrachloride and titanium tetrachloride contained in a hydrogen carrier gas, to produce low grade vaporous aluminum subchloride and silicon subchlorides or titanium subchlorides, respectively, and conducting said

low grade subchlorides directly upon formation thereof, with said carrier gas, to a metallic body to be coated, for interaction with said body at a temperature which is below the temperature at which said subchlorides are formed, to cause deposit on said metallic body of an aluminum alloy coating."

2 claims, 2 figures.

No. 2,886,477, 5/12/59—Phosphating—Chester Smith, Wagner County, Mich.

A composition for cleaning and phosphating is described as 50–80 per cent of an aqueous acidic phosphating solution, 4–30 per cent of a hydrocarbon solvent and 10–30 per cent of an emulsifier and an ethylene oxide condensation product.

20 claims, figure.

No. 2,886,498, 5/12/59—Preparing Steel for Enameling—G. Shepard, assignor to Republic Steel Corp., Cleveland, Ohio.

After suitable cleaning steps the ferrous surface is zinc plated to a thickness of 0.00001–0.00005 in. The zinc is then stripped and a nickel deposit is laid down.

3 claims.

No. 2,886,499, 5/12/59—Coatings for Molybdenum—G. Schaer and John Beach, assignors to USA (Navy).

Strike with chromium (0.0005 in.), plate 0.0015 in. of gold, then plate with chromium to 0.003–0.005 in.

3 claims.

No. 2,886,500, 5/12/59—Plating Copper Alloys—C. Faust, *et al.*, assignors to Battelle Development Corp., Columbus, Ohio.

A process is given for plating a copper-tin alloy by passing an electric current through a bath of:

	g/l
A pyrophosphate (Na^+, K^+, NH_4^+).....	8–300
Cuprous Cyanide.....	2–230
A cyanide (K^+, $Na^+NH_4^+$).....	2–350
A stannous salt ($SO_4^=$, Cl^-, $P_2O_7^=$).....	0–50
A stannate salt (K^+, Na^+, NH_4^+).....	0–250
A lead salt (eq to PbOAC).....	0.05–0.6
A lower aliphatic carboxylic acid salt....	0.05–0.75 mol.

8 claims.

No. 2,886,505, 5/12/59—Plating Apparatus—A. Singleton and T. Gill, assignors to The Singleton Co., Cleveland, Ohio.

A barrel plating apparatus is described in 12 claims and 11 figures.

No. 2,886,924, 5/19/59—Buff—A. Rock, assignor to F. L. and J. C. Codman Co., Rockland, Mass.

A buffing element with a metallic center is described.

7 claims, figure.

No. 2,887,210, 5/19/59—Plating Apparatus—D. Borodin, assignor to Allied Research Products, Inc., Baltimore, Md.

A conveyor for plating racks is described.

12 claims, figure.

No. 2,887,367, 5/19/59—Resist Etching—S. Eisner, assignor to Ford Motor Co., Detroit, Mich.

To produce a precision etched pattern coat a silk screen with silicone, place screen over the metal to be etched, selectively deposit an acid resistant resin through the silk screen and etch the metal unprotected by the resin.

3 claims.

No. 2,887,406, 5/19/59—Gas Plating of Titanium—H. Homer, assignor to The Commonwealth Engineering Co., Dayton, Ohio

A method of plating titanium on surfaces by evacuating a chamber containing the material to be plated and introducing a heat decomposable organo-titanium compound and heating to plate the titanium.

11 claims, figure.

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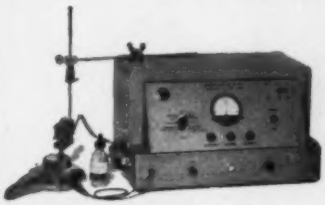

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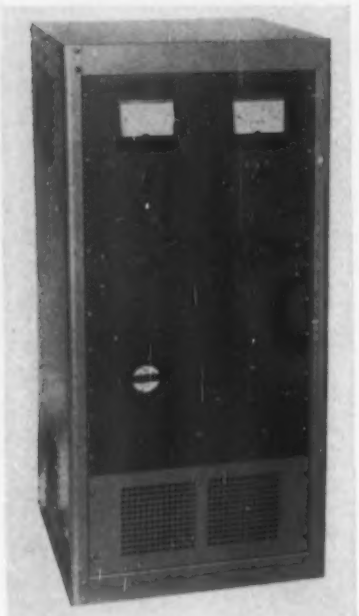


E—101. Automatic Power Regulatos—Matthew Laboratories is introducing itr Model HCVS-250-20 constant current and constant voltage automatic switchover regulated power supply used primarily for tantalum capacitor production, precision electroplating and battery charging. The application of constant current and Faraday's Law in this power supply results in quantitative coulomb or electric charge transfer for the controlled formation of oxide films or material deposition or removal.

A major feature is automatic switchover. When on constant current operation at a desired current, the supply will automatically switch to constant voltage operation upon reaching a predetermined voltage due to load resistance buildup.

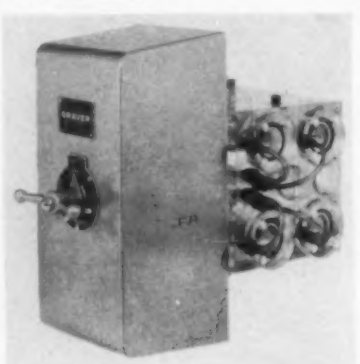
E—102. Ultrasonic Unit—An ultrasonic cleaner for applications in which average energy levels are required, has been announced by National Ultrasonic Corp. Model 120 in National Ultrasonic's Standardline, the unit features a 2-gal tank made of heavy gage polished stainless steel. Tank is 10½ in. long, 8½ in. wide and 6 in. deep and has deep drawn rounded corners to facilitate the rinsing out of contaminants removed by the ultrasonic energy. Twenty-seven per cent of the tank bottom is covered with driving elements. Actual radiating surface is 24 sq in.

E—103. Dry Acid Powder—Heatbath Corp. introduces Aricid B, a completely water soluble dry acid powder consisting of a mixture of acid salts, activators, corrosion inhibitors and surface active agents. Aricid B is used as a replacement for liquid acids, especially muriatic and sulfuric.

Solutions of Aricid B are made by dissolving from 1 ounce to 3 pounds of Aricid B salts per gallon of water, depending on the application.

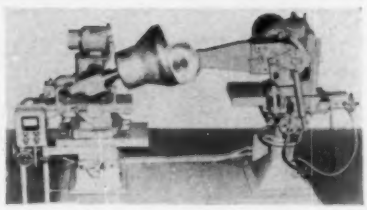
Aricid B solutions are used as activating dips on steel, brass, copper and zinc die castings, prior to plating, phosphating and black oxidizing. It is also used for removing rust, heat treat scale, oxides, soldering flux and as a chrome plate stripper.

E—104. Single Control Valve—A patented single control valve for directing the flow of liquids in zeolite softeners, ion exchange units and filters has been introduced by Graver Water Conditioning Co. Called the Monotrol, the valve is designed to perform the functions of a nest of individual valves while providing ease in operation and maintenance. It is available in cast iron or in acrylic plastic for corrosive service, and can be operated manually or automatically.



Features of the valve include pilot control, positive hydraulic pressure actuation and easy maintenance. All internal moving parts can be readily removed for inspection and service without dismantling the connecting piping or removing the valve from the unit on which it is being used. In addition, the design provides for low pressure loss during operation and no contamination of effluent with influent.

E—105. Polishing Machine for Bowl-Shaped Parts—An improved design of standardized Acme automatic polishing machine for finishing a wide variety of shapes and sizes of reflectors and bowl-



shaped metal parts is now available from Acme Manufacturing Co. The machine will finish reflectors, oval shapes, bubble-type surfaces, conical, cylindrical and bowl shapes in a fully automatic cycle of operation. Parts made of aluminum clad material, stainless steel, low-carbon steel, copper, brass can be finished on the reflector polishing machine.

One unique feature of the machine is the automatic control of finishing wheel pressure to prevent excessive pressures encountered when contact surfaces change from large to small radii as in oval reflectors.

E—106. Bright Copper Plating Process—Hanson-Van Winkle-Munning Co. has announced the availability of a new bright copper cyanide process. Trade name of the process is Copper-Lume.

It is said to offer the following characteristics: Smooth, bright deposits over a wide temperature and current density range; good metal distribution; solution simple to operate and control. Deposits can be buffed with ease. Copper-Lume bath constituents can include either potassium salts, a mixture of potassium and sodium salts, or sodium cyanide only. The deposits do not require activation before subsequent nickel plating.

E—107. Spray Gun—A new hand held Plasmatron spray gun, weighing less than four pounds and only 3.5 inches long, capable of operation on gases such as argon and nitrogen, at power levels to 40 KW, has been developed by the Giannini Plasmadyne Corp.

This new device is said to extend the range and capabilities of materials engineering into refractory metals, carbides, borides, silicides, and nitrides. According to the manufacturer practically any material can be spray coated on steel, molybdenum, niobium, aluminum, magnesium, and many plastics. Materials such as titanium carbide, tungsten, chromium or titanium can also be deposited on most ceramic base materials or metals without metallurgical, crystallographic, or chemical charges, Giannini officials state.

KNOWLEDGE OF INESTIMABLE VALUE IN THESE AES RESEARCH PROJECT REPORTS CURRENTLY AVAILABLE

Cleaning and Preparation of Metals for Electroplating, IV, V, VI & VII—By H. B. Linford & E. B. Saubestre — *Serial 26, Project 12, $3.50*

Methods for Testing Thickness of Electrodeposits, II & III—By H. J. Read & F. R. Lorenz — *Serial 27, Project 7, $1.35*

Porosity of Electrodeposited Metals—By N. Thon, D. G. Kelemen, L. Yang, S. Yang, D. Dean — *Serial 28, Project 6, 85 Cents*

The Analysis of Electroplating Solutions for Major Constituents—By E. J. Serfass & M. H. Perry — *Serial 29, Project 2, 90 Cents*

Effect of Basis Metal Condition on Plating, I & II By A. E. R. Westman & A. F. Mohrnheim — *Serial 30, Project 14, $1.10*

Effect of Surface Finishing on Nonferrous Base Metals on Protective Value of Plated Coatings—By G. J. Kahan, W. W. Macchia, J. M. Fairbank — *Serial 31, Project 4, 45 Cents*

How the Small Electroplater Can Treat Cyanide Plating Waste Solutions with Hypochlorites—By Bernett F. Dodge and Walter Zabban, Yale University, New Haven, Connecticut — *Serial 33, Project 10, 50 Cents*

Effects of Impurities and Purification of Electroplating Solutions, IX, X & XI—By Dr. D. T. Ewing, Dr. A. J. Smith & Dr. W. O. Dow — *Serial 34, Project 5, 50 Cents*

Cleanability and Oil Spreading Rates—By H. B. Linford & P. E. Grubb — *Serial 35, Project 12, 50 Cents*

The Nature, Cause and Effect of the Porosity in Electrodeposits, I & II—By Fielding Ogburn, Asaf Benderly and Margaret Hilkert — *Serial 36, Project 13, $1.00*

Microthrowing Power, A Literature Search—By Esther B. Leffler and Henry Leidheiser Jr. — *Serial 37, Project 17, 75 Cents*

The Influence of the Physical Metallurgy and Mechanical Processing of the Basis Metal on Electroplating IV—By M. H. Jones, Chih-Yeu Lu and J. Zajdowski — *Serial 38, Project 14, $1.25*

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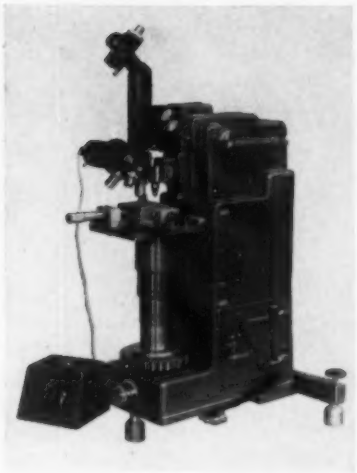

E—108. Micro Hardness Tester—A new micro hardness tester, with a vertical capacity of 8 in., has been announced by the Torsion Balance Co.

The Kentron micro hardness tester applies dead weight loads from 1 to 1000 grams. (Additional weights for applying heavier loads up to 10,000 grams can be obtained as optional equipment).

Known as the Model AK 8, this equipment is basically a production control instrument but has the same accuracy as the Model AK, a standard research instrument used in metallurgical laboratories.

E—109. Solvent/Detergent—Teclene No. 135 a new solvent-detergent of high penetrating and emulsifying action, has been announced by Tect, Inc. It is a form of Teclene modified with chlorinated solvents of low volatility to remove heavy oil, grease and other contaminants. It may be brushed or sprayed on the surface, then rinsed with either water, steam or solvents. The addition of three parts of water to seven parts of No. 135 forms a gel which may be applied with brushes to vertical surfaces, yet is easily rinsed with water.

The product has light odor. Although alkaline, it may be used in the cleaning of all metals and is said not to attack aluminum.

E—110. Centrifugal Pumps—Latest additions to the Vanton Pump and Equipment Corp. line of fluid handling products are two polypropylene centrifugal pumps which possess resistance to solvents, greases, oils and many common acids and chemicals at high temperature.

Available in two sizes these pumps offer a capacity range of from 2 to 80 gpm. Pump Model ZP-25 has a 2-30 gmp capacity and pump model ZP-35 an 8-80 gpm capacity. Pumps can handle solution temperatures up to 300F.

E—111. Ultrasonic Generator—A new ultrasonic generator that requires no tuning or monitoring has been announced by Industrial Ultrasonics Corp. The new generators, expected to help break production bottlenecks, operate with a simple on-off switch and make use of a fundamental principle of automation, feedback.

The actual amount of ultrasonic activity in the cleaning tank is measured and used as a basis for varying the output frequency of the generator. There is nothing on the Industrial Ultrasonics generator to confuse the unskilled operator or to require extensive operator training, it is claimed.

E—112. Infra Red Ovens—Modular infra red ovens that are claimed can be made to fit any drying system, give uniform heat over entire emitting area, and can be used with any conveyor are now available from Infra Red Systems, Inc. The basic module of these ovens is called RediRay, a completely self-contained heater which uses a ceramic face as a source of infra red radiation. The ceramic face is brought up to emission temperature by the formed resistance wire embedded in an insulating block back of it. The entire heating block is backed up by alternate layers of batt and reflective insulation. All are mounted in a sheet metal shell of modular dimensions.

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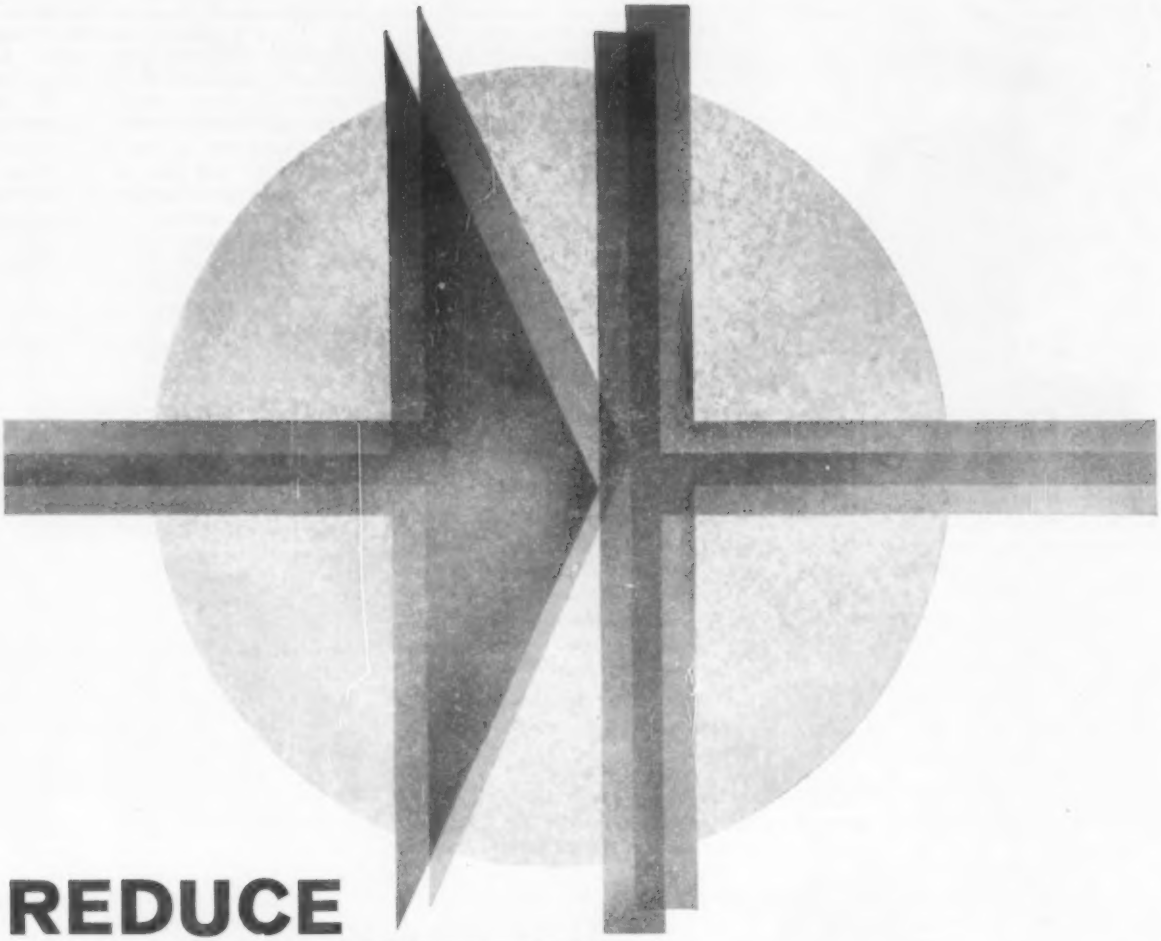

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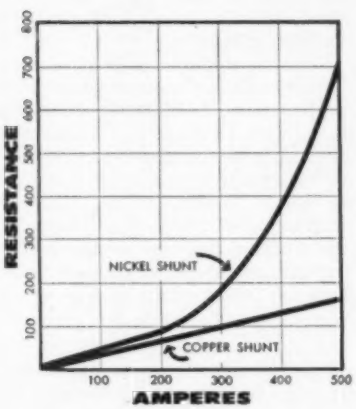
A braided nickel shunt on the new Equaload Brush completely eliminates unequal current distribution because nickel's resistance to current flow increases proportionately with temperature rises. See curve below.



When any brush accepts more than its proportional share of current, the temperature of the shunt rises, its resistance increases and current is immediately distributed equally among the other brushes.

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H-VW-M Motor Generator Sets – Available up to 50,000 amps. Standard voltage ratings are from 6 to 250 volts.

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E—113. Oscillating Platform—Polishing and buffing heads which require oscillation may now be mounted on an oscillating platform produced by Murray-Way Corp. This action was previously obtained by oscillating the work spindle itself through the bearings.

The new oscillating platform is sturdily built and mounted on heavy lateral bearing rails which hold the head in absolute alignment. The polishing head is simply bolted to the steel platform.

A cam-activated arm and a drive reducer move the entire head and its mounting smoothly forward and back, affording even more accurate surface smoothness than was possible by the conventional spindle oscillation according to the manufacturer.

E—114. Grinding Wheel—To give greater flexibility for cleaning and polishing contoured metal parts, a "slashed" version of the Grind-O-Flex flexible grinding wheel has recently been introduced. The abrasive cloth leaves are cut into thin strips. As the wheel rotates the abrasive fingers mold to irregular shapes and get down into places which formerly could only be finished by hand. Wheel sizes are 14 and 16 in. diameter and widths are available from 3 to 60 in. Grits available from No. 50 to 320 aluminum-oxide cloth.

The wheels are said to be equally as effective on soft metals as on hard. They can be used for satin finishing aluminum as well as stainless steel.

E—115. Abrasive Wheels—Two new designs in abrasive flex wheels have been introduced by American Buff Co. The two new designs, Uniflex and Amflex, are not grit-coated buffs, but buffs containing grain-in-depth that retain maximum abrasive efficiency throughout the entire life of the buffing wheel.

Amflex and Uniflex buffs are said to make the conventional separate departments for die-trimming, removal of orange peel, and hand-finishing unnecessary. They save the usual loading, unloading and reloading of work. This is done by installing these abrasive wheels ahead of other buffs on a single lathe, producing an "automated" finishing set-up. This allows complete finishing with a single automatic in a single operation. There are 16 sizes of Uniflex and Amflex abrasive wheels with 3-, 5-, 7- and 9-inch centers. Flex wheels are available in 80-, 120-, 240- and 320-grit

E—116. Ultrasonic Cleaner—A completely new line of multipower ultrasonic cleaners, said to deliver up to three times more cleaning power than other ultrasonic cleaners having the same output power ratings, is now being produced by Acoustica Associates, Inc.

The key to this improvement in ultrasonic cleaners is claimed to be the newly developed Acoustica multipower transducer for which patents are pending. It uniquely combines the advantages of the old type transducers while eliminating the disadvantages. The new design compresses piezoelectric ceramic material between two solid metal sections, providing an increase in ultrasonic cleaning power while insuring durability.

E—117. Black Oxide Process—Mitchell-Bradford Chemical Co. announces a new "Activated" Black Magic for producing a black oxide finish on steel. This is the latest development in the line of Black Magic blackening processes and it is a step forward in black oxide processing. It is said to be a new approach to a black oxide process because of its constant, automatic, self-regenerating, decontaminating, catalytic action along with other vitally important and unusual characteristics. "Activated" Black Magic contains new concepts of activators, catalysts, penetrants, and rectifiers. This produces many outstanding advantageous results in operation, processing and final resultant black finish. New "Activated" Black Magic reduces processing time, lowers salt consumption because of excellent drain off and less salts per gallon. It is extremely free rinsing and produces a denser black and clean finish. The dragout is 25 to 30 per cent less than conventional blackening solutions.

New "Activated" Black Magic will blacken many types of hardened and also passive steels which heretofore were finishing problems. The black oxide finish produced also has more corrosion resistance than previous types of black oxide finishes.

As in previous Black Magic black oxide processes the new "Activated" Black Magic for steel is a single bath with one chemically balanced salt for additions to the blackening solution.

E—118. Bright Nickel Process—Hanson-Van Winkle-Munning Co. has announced the availability of a new bright nickel process—Superlume. Superlume, according to the manufacturer, gives the brightest, smoothest nickel deposit obtainable. It yields deposits which are exceptionally bright at high and low current density areas and has the ability to level-out scratches to an extraordinary degree.

The process is also characterized by tolerance to inorganic impurities such as zinc and copper and the bath is amenable to continuous carbon treatment resulting in relative freedom from organic contamination.

After original make up, only two addition agents are used. One provides ductility, stress relief and tolerance to impurities. The second addition agent provides high brightness and leveling.

TRADE LITERATURE

L—101. Ultrasonic Cleaning — National Ultrasonic Corp. announces the availability of a 12-page Ultrasonic Cleaning Primer for use as a guide by potential users of ultrasonic cleaning equipment.

The primer is designed to provide a clearer understanding of what ultrasonic cleaning is, how it works, areas in which it can be employed and various solvents and detergents available for use with this kind of equipment. It is divided into five sections.

L—102. Gold Plating—An 8-page paper on industrial gold plating, by E. C. Rinker, technical director, Precious Metals Division, Sel-Rex Corporation, is available again. A prize winning technical paper originally presented before the 40th Annual American Electroplaters' Society, this definitive write-up has been reprinted a dozen times due to the ever present demand.

The paper treats, in detail, such topics as bath composition, equipment and operating conditions, and comparative metallurgical characteristics of 24K gold plate on various base metals. Profusely illustrated with photomicrographs of gold plated surfaces and cross sections, the paper also includes a series of graphs and tables indicating rates of deposition at various current densities and under different operating conditions.

Also a new 7-page technical paper covering metallurgical properties and applications for low *p*H acid-type gold plating formulations, trademarked Karatclad, has been made available by Sel-Rex Corporation.

Essentially a technical exposition brought up-to-date on properties, uses and data on bath maintenance, composition, dragout control, the new booklet features a new section on Karatclad colors, precise color control methods, color measurement, light sources and their effects. It describes colors obtained from each Karatclad gold formulation, shows how to pick out and maintain customer-preferred shade.

Adaptable to both still and barrel plating methods, Karatclad gold produces tarnish-free deposits to any desired thickness with a jewelers' finish directly from the bath, according to the booklet.

L—103. Ultrasonic Cleaning—Alkaline and acidic detergents are frequently better for ultrasonic cleaning than the more viscous solvents. This is one of the six practical tips given in a new Service Bulletin No. 16A recently published by Oakite Products, Inc.

Based on extensive field work with this fast-spreading cleaning method, the bulletin describes the process by which high frequency sound waves impart intense scrubbing action to solutions to speed precision cleaning. The method's success, however, depends in large measure on the cleaning solution, according to the bulletin, which then describes compounds which have proved effective, and the types of operation ultrasonic cleaning does best.

L—104. Finishing Systems—An illustrated index of the complete finishing systems available from The DeVilbiss Co. is now available.

The manufacturer is said to be the only one in its field manufacturing a complete selection of all equipment items needed for a fully integrated finishing installation with each component engineered to work together. Included are spray guns, automatic spray coaters, flow and dip coaters, industrial ovens, air compressors, dust collectors, spray booths, industrial power washers, hot spray systems, paint tanks and pumps, hoses and connections, and phosphatizing systems.

L—105. Gold Spray Finishes—The new bronzeless gold spray finishes developed and marketed by the Bee Chemical Co. are discussed in an 8-page booklet just published. The new finishes provide an appearance comparable to coatings made by the use of bronze powder but offer advantages over these conventional finishes by being lower in cost, nontarnishing, non-gelling, harder, and easier to apply.

L—106. Pickling Compounds—A 4-page technical bulletin available from Frederick Gumm Chemical Co., contains information on powdered pickling compounds for various applications.

The bulletin describes the advantages of powdered pickling compounds, then cites a number of specific pickling problems with the compound recommended for each, together with a description of the compound. Description includes recommended working temperatures, concentrations used and length of treatment time.

L—107. Brightener—A liquid acid material used to brighten stainless steel, aluminum, and steel is described in Technical Data Sheet No. 81, a four-page usage and instruction sheet prepared by MacDermid Incorporated. Called Electro-Gleam 55, this solution is said to remove scratches and other surface defects, deburrs and removes sharp edges, improve corrosion resistance and adherence of plated work and reduce friction.

L—108. Water Treatment — Clarification of high color/low turbidity waters is discussed in new Technical Reprint T-176, available from Graver Water Conditioning Co. The title of the reprint is, "Design Considerations and Operating Experiences in Clarification of High Color/Low Turbidity Waters."

The paper points out that high color/low turbidity supplies present special treatment problems because they are difficult to coagulate and clarify. The paper covers the coagulants and aids to be considered for this type of water and the design and operating considerations for adequate clarification.

Four case histories are included to show successful clarification of these waters and there are numerous tables, curves, flow diagrams and illustrations.

L—109. Filter Pump Guide—An informative filter pump selection guide listing many electroplating and industrial solutions and their recommended filter pumps is included in the new catalog, Bulletin M-1, just published by the Sethco Manufacturing Corp.

This 8-page brochure also contains data and facts about the various components and materials of construction incorporated in Sethco filter units to achieve optimum depth filtration for any particular application.

Included too in the M-1 Bulletin are illustrations and specifications of 20 representative models ranging from 50 to 2700 gal/hr capacity. Separate specification sheets describing each unit in greater detail are also available.

L—110. Abrasive Finishing—A new data sheet provided by The Lea Manufacturing Co. covers the abrasive finishing of brass and bronze. Instructions are applicable to all forms including extrusions, stampings, castings, spinnings and die castings. The sheet gives data on wheel heading, lubrication, surface speed and recommended types of buffs.

L—111. Waste Treatment Equipment—A bulletin listing and describing custom designed process water and waste

treating equipment for the metallurgical industries is available. The Infilco Inc. Bulletin 90 is eight pages in length. It outlines applications and features of 22 categories of equipment available for hydrometallurgical process operations which use ion exchange, chemical feeding, leaching, oxidation, carbonation, purification and clarification.

L—112. Lapping-Polishing Machines—A new catalog section on vibratory lapping-polishing machines has been issued by Syntron Co. Illustrated section presents complete descriptions, specifications and data for four vibratory lapping-polishing machines. These machines are claimed to provide easy, mechanical polishing of metallurgical samples for microscopic examination.

L—113. Strippable Plastic Coating—A revised bulletin on Thermo-Cote strippable plastic coatings has just been published by Bischoff Chemical Corp. The literature includes a description of Type N-4 compound used as a stop-off in plating.

Type N-4 material is said to be easily applied to the part to be masked by dipping in Thermo-Cote hot melt. Thereafter it is cut and peeled away where desired. Other types of strippable coatings for protecting metal parts and tools are also described.

L—114. Demineralizer continued—Designated as the Uni-Pac "M" series, models of the new demineralizer are available in capacities from 2100 to 13,200 GPH using raw water with 10 grains per gallon total exchangeable anions.

Operating valves and piping are corrosion-proof PVC and exchange tanks are lined with the same material. Auxiliary polyethylene regenerant tanks are provided for acid and alkali.

Units are equipped with conductivity and rate-of-flow indicators.

A brochure describing the new packaged demineralizer is available.

L—115. Slings—A new folder describing slings made of synthetic webbing has just been released by American Manufacutring Co., Inc.

Amco Slings, made of nylon, dacron or polypropylene, are offered in five styles with three types of hardware for various applications. Charts list widths ranging from 1 to 10 in. thicknesses, breaking strengths and safe working loads.

The softness of the synthetic fibers permit highly polished surfaces, machined or painted finishes and delicate assemblies to be moved without marring, scratching or denting. The high flexibility of an Amco Sling enables it to conform to any shape.

L—116. Aluminum Etchant—Pennsalt Chemicals Corp. has introduced a new aluminum etchant in solid form. Called AE-16S, the new compound is claimed to be an improvement over Pennsalt's aluminum etchant AE-16 in flake form.

Offering all of the etching advantages of AE-16, the new product is dustless, gives off no heat of solution, is easier to handle, and is lower in cost. Data sheets and other additional information on AE-16S are available.

L—117. Temperature Control—GER-1206 on temperature control of heat-treating furnaces is a 24-page General Electric bulletin and reprints a series of articles which appeared in *steel* magazine.

The illustrated publication contains information about thermocouples, control instruments, control elements, control systems and special systems. Author discusses all phases of temperature control listing definitions, basic types, and how to select the proper item.

L—118. Electroplating Equipment—An 8-page bulletin available from Frederick Gumm Chemical Co. Inc., describes the line of plating equipment and supplies being distributed by the firm for leading manufacturers.

Included are immersion heaters, steam generators, vapor degreasers, spray washing machines, temperature controllers, rectifiers, filters, tanks, racks, baskets and plating barrels. Also described is equipment for testing current density, rack current, plating thickness, *p*H and corrosion resistance.

Special equipment includes custom-designed automated plating equipment and a patented double oscillating plating cylinder designed to provide improved mixing action combined with movement of the work across the cylinder to insure uniform plating deposit.

L—119. Chemical Cleaning—A new bulletin has been issued by Chas. Pfizer & Co., Inc. Technical Bulletin No. 102, Pfizer Products for Chemical Cleaning, covers in 17 pages such subjects as cleaning aluminum metal and aluminum alloys, stainless steel cleaning, alkaline derusting and paint stripping, power plant cleaning, and general chemical cleaning.

L—120. Valves—A 4-page bulletin available from Atlas Valve Co., describes the Atlas No. 171 Type D valves which can be used as pressure reducing or relief valves or pump governors with steam, oil, water, gas or air. The single-seat, tight-closure valves are available as direct or reverse acting in either bronze or steel.

The two-color bulletin includes features, applications, operation, installation and ordering information as well as valve photos, drawings and capacity tables.

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PERSONALS

WALTER H. VENGHAUS, specialist in manufacturing and fiscal control, has joined The Narda Ultrasonics Corp., Westbury, N. Y., as vice president and manager of manufacturing.

Mr. Venghaus, a resident of Oyster Bay Cove, L.I., was formerly associated with National Research Associates, Inc. of College Park, Md., and has held executive positions with Flight Refueling, Inc.; Baltimore, Reaction Motors, Inc., Denville, N.J.; and Industrial Acoustics Company, Inc. He also was previously associated with the consulting firm of Frederick E. Anderson, Inc., New York.

Mr. Venghaus, studied at Brooklyn Polytechnic Institute and Purdue University.

W. H. Venghaus

L. R. Malley

L. RICHARD MALLEY has been appointed advertising manager of Climax Molybdenum, Co., a division of American Metal Climax, Inc.

In his new post, Mr. Malley will coordinate the advertising, publicity and sales promotion activities of Climax' several product departments. Previously he was assistant to the president of American & Foreign Enterprises, Inc., serving as liaison between American and European industrial firms.

Mr. Malley is a graduate of LaSalle College, Philadelphia, where he earned his BA degree.

●

WALTER C. GUILTINAN has been appointed sales representative in the Pittsburgh and Western Pennsylvania areas for Hanson-Van Winkle-Munning Co.

Upon graduation from Notre Dame in 1953, Mr. Guiltinan joined the sales force of a leading metal finishing supplies distributor and remained there until joining H-VW-M. Mr. Guiltinan, 34, served in the United States Navy during World War II and holds medals from all three theatres.

He reports to Calvin E. A. Scilla, district manager at Cleveland. His office will be in Pittsburgh.

PETER ARNOLD, formerly Development Engineer for automatic equipment with Hanson-Van Winkle-Munning Company, has been appointed Eastern Sales Manager for equipment of The Meaker Company, pioneer manufacturers of automatic systems for batch or continuous metal processing and finishing since 1899—a wholly-owned subsidiary of Sel-Rex Corporation, it has been announced. Although The Meaker Company factory and offices are located in Chicago, Mr. Arnold reportedly will make his headquarters at Sel-Rex's executive offices in Nutley, New Jersey, in order to be closer to his area of responsibility.

A Mechanical Engineering graduate of the University of Virginia, Mr. Arnold has patented several inventions for automatic load and unload machines and continuous conveyor-type equipment, for electroplating, metal finishing and processing.

According to the announcement, Mr. Arnold will be responsible, in his new post, for maintenance of dealer and distributor liaison, and for the technical training of sales and service personnel on The Meaker Company equipment.

Mr. Arnold, who resides in Elberon, New Jersey, is a member of the American Society of Tool Engineers and the American Chemical Society.

P. Arnold

J. L. Ross

JEROME L. ROSS has been appointed Assistant General Manager of The Meaker Company, manufacturers of automatic metal finishing equipment since 1899, newly acquired subsidiary of Sel-Rex Corporation, has been announced by Morris M. Messing, President of both companies. Sales Engineer with Sel-Rex since 1949, Ross has been in charge of plating equipment and supplies sales for two years, and, most recently was Manager of the company's Equipment Division, responsible for engineering and pricing.

A Chemical Engineering graduate of Columbia University, Mr. Ross was previously associated with DuPont in Sales, Research and Technical Service for eleven years, five years with the Carlton-Cook Plating Company as Plant Superintendent, two years with Century Plating and Engineering as Plant Manager, and one year with North American Aviation as Superintendent of Finishing.

According to the announcement, in his new position, Mr. Ross will share the responsibility of engineering, manufacturing and sales for Meaker products with Mr. Victor Finston, Executive Vice President and General Manager, who had been President of The Meaker Company for many years.

Mr. Ross will make his headquarters at The Meaker Company factory and general offices located at 1629–41 South 55th Avenue, in Chicago.

●

WILLIAM J. Miller has been appointed manager of sales and production for the Bias Buff Division, Riegel Textile Corp., at Conover, N. C. Mr. Miller has been with the Buff Division in various capacities since he joined the organization in 1939. Riegel's buff production facilities were recently transferred to Conover, N. C. from Jersey City, N. J.

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MARVIN R. MOYER has joined the industrial department of Wyandotte Chemicals Corp. as a product-service representative. He will work out of the J. B. Ford Division's Philadelphia, Pa. office.

Mr. Moyer's eight-year industrial background includes process engineering work, metal cleaning and finishing, and electroplating.

●

JOHN W. PRIESING has been named manager of the newly established West Coast Sales Branch of Solvay Process Division, Allied Chemical Corp.

The Solvay branch will be located at Allied Chemical's Consolidated Sales Office, 235 Montgomery Street, San Francisco, Calif.

Mr. Priesing, a liberal arts graduate of Amherst College, received a Master's degree in Business Administration from Harvard Business School. He joined Allied Chemical in 1956, as a financial analyst. In December of that year, Mr. Priesing transferred to Solvay Process and was assigned to the Detroit, Michigan Sales Branch. He became the division's West Coast sales representative last year.

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Dulac SS-49—For reducing stain spotting on brass plated or oxidized metal parts. Resists outdoor exposure.

Dulac D-129—For use on aluminum window frames, which are subject to "lime" and cement burns during building construction. Resists alkali, moisture, alcohol, grease and other household chemicals.

WATER DIP COATINGS

For use on plated or chemically cleaned metal parts immediately after the last water rinse, while the parts are still wet with water, to prevent tarnishing and protect the plated or cleaned parts during processing. "Keeps clean metal clean". It may also be used on metal electronic equipment parts where conductivity must be maintained, such as radio chassis, test equipment, coil terminals. After coating, parts can be soldered, spot welded, prevents "fungus growth".

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Q. A. Dietz

G. Dietz Jr.

GEORGE DIETZ JR. has been named executive vice president and general manager of American Chemical and Refining Co., Waterbury, assuming management of all phases of company operation. He will report directly to the president.

QUENTIN A. DIETZ has been elected vice president and general sales manager to head up American Chemical's new marketing and sales program.

NEWELL W. MITCHELL has been named director of research and development. He will devote his time exclusively to the development of new technical electroplating processes involving gold and silver.

•

MARVIN LANE, technical director of Gruver Water Conditioning Co., New York, a division of Union Tank Car Co., has been named general manager of that division. He succeeds H. T. Sulcer, who recently resigned.

As technical director, Mr. Lane spearheaded a Graver Water research and development program that resulted in major improvements in liquid conditioning processes and techniques and in the introduction of new items of equipment.

Mr. Lane received his BS degree in chemistry, cum laude, in 1940. Shortly after he began graduate work at the University of Pennsylvania, he was called to engage in vital war projects.

During the war, Mr. Lane participated in development of desalting kits for downed airmen and castaways; desiccants to protect materials during storage; and oil removal filters for Liberty ships. He took part in research to find new ion exchange resins to broaden the use of ion exchange in purifying process liquors. He was awarded the Certificate of Merit, a government citation, for his services.

The new general manager, who was born in Philadelphia and now resides in Cranford, New Jersey, is a frequent speaker at technical meetings and is the author of numerous papers. Among the professional societies to which he belongs are the American Chemical Society and the American Society for Testing Materials.

M. Lane

J. Geyer

JOHN GEYER, manager of the product development department, Metalworking Chemicals Division, Amchem Products, Inc., Ambler, Pa., has been promoted to technical assistant to Amchem's president, Gerald Romig.

Mr. Geyer will be succeeded in the product development department by **HUGH GEHMAN,** who has been his assistant since January, 1955.

Mr. Geyer, a native of Philadelphia and a graduate metallurgical engineer of the 1949 Class of Lehigh University, joined Amchem in December 1950, as a metalworking chemical technician, becoming manager of the metalworking chemicals development department in 1953. Prior to this he was a plant metallurgist with the Aluminum Co. of America, Massena, New York.

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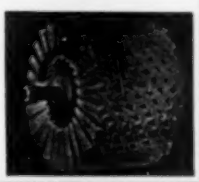

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R. McGILL has received appointment as chief chemist of The Diversey Corporation (Canada) Limited. Mr. McGill obtained his degree from the University of Glasgow, Scotland, where he specialized in inorganic, organic and physical chemistry. His experience in analytical chemistry has qualified Mr. McGill for his new post, where he will be doing research and development work on new products. During the next few months, laboratory facilities at the Clarkson Ontario plant are to be expanded.

R. McGill

Dr. E. J. Serfass

DR. EARL J. SERFASS, chairman, department of chemistry, Lehigh University, has been elected a member of the board of directors and vice president in charge of research and development of Milton Roy Co., Philadelphia. Though this new position necessitates his resignation from Lehigh University, Dr. Serfass will continue to serve as president of Serfass Corp., 345 Conestoga Street, Bethlehem, Pa., which will become a wholly owned division of the Milton Roy Co., and will maintain his offices there for the immediate future. **DR. FRED ACHEY,** vice president of Serfass Corp., will continue his services with the new corporation.

Through his research and consulting activities, Dr. Serfass has been responsible for the development of a number of devices for electrical and optical methods for chemical analysis including such commercial items as the Serfass conductance bridge, the Fisher-Serfass relay, electron ray titration unit and others. In 1956, he developed a high speed hydrogen analyzer for the determination of hydrogen in metals. On numerous other occasions, he has advanced the field of analytical chemistry through the introduction of new instruments, several of them designed and manufactured by the Serfass Corp., which he founded.

A native of Allentown, Pennsylvania, Dr. Serfass has been associated with Lehigh University through most of his professional life. There he performed work leading to the degrees of BS and MS in chemical engineering, and a PhD. in chemistry. Upon receiving his doctorate, he successively served as Instructor, Assistant Professor, Associate Professor, Full Professor, and chairman of the department of chemistry. As an administrator and educator, he has authored, or joined in authoring some eighty-four papers, the majority dealing with analytical techniques and instruments.

Active in learned and professional societies, Dr. Serfass is a National Councilor of the American Chemical Society, past national research chairman of the American Electroplaters' Society, and past chairman of the national education committee of the Instrument Society of America. He also holds memberships in the Optical Society, American Institute of Physics, Electrochemical Society, Sigma Xi, and Tau Beta Pi.

●

DR. FRED A. ACHEY received his BS in chemistry from Franklin & Marshall College, and his MS and PhD. in chemistry from Lehigh University. A resident of Bethlehem, his societies include the American Chemical Society and Sigma Xi.

●

D. H. CURRIE, product manager for vitrified products—metallic applications of the Carborundum Co. is appointed field sales engineer for the Buffalo Sales District.

P. R. THOMAS, field sales engineer for the Detroit Sales District, is appointed product manager for vitrified products—metallic applications.

A. E. BENNETT, assistant product manager of resinoid products for metallic applications, is appointed field sales engineer for the Detroit Sales District.

●

JOHN H. FONNER JR. transfers from Diamond Alkali Co.'s Muscle Shoals, Ala. plant to the Edgewood, Maryland plant as assistant plant manager.

ERICH G. SCHLAILE moves from the Edgewood plant to Diamond's Deer Park, Texas plant as a process engineer.

ROBERT S. STARK also transfers from the Edgewood plant to the research and development department at Painesville, Ohio.

Mr. Fonner joined Diamond five years ago as a plant chemist at Muscle Shoals. Previously, he was with Columbia Southern Chemical Corp., Lake Charles, La. for six years as assistant chief chemist and from 1946 to 1948 as a control chemist with Southern Carbon Company, Monroe, La.

A graduate of Louisiana College, Pineville, La., where he earned his BS degree in chemistry in 1946, Mr. Fonner holds membership in the American Chemical Society, Research Institute of America and Industrial Management Club. Mr. Schlaile also joined Diamond five years ago as production control supervisor at Diamond's Edgewood plant. His previous experience centered in the chemical engineering field.

He holds a BS degree in chemical engineering from the University of Maryland where he graduated in 1954.

Mr. Stark joined Diamond in September 1933 as a group leader at the Painesville plant. His long experience with Diamond during the past quarter century has been in supervisory capacities in the electrochemicals field.

●

BYRON A. BOWMAN has been appointed plant manager and **RALPH G. DEARTH** has been transferred to the sales department of K & F Metal Finishers, Inc., Dayton, Ohio. These organizational changes were made to plan for production increases and plant expansion to cover more areas of the metal finishing field as well as to include other fields of endeavor.

Mr. Bowman is a graduate of Defiance College, Defiance, Ohio and has had one year of post graduate work in chemical engineering at Ohio State University. During the past 18 years he has been involved in research, development and production work at Aero-Products-Allison, Division of General Motors, where he was supervisor of the engineering process and standards department. Mr. Bowman has had experience in metal finishing, plating, painting, adhesives, brazing, corrosion study, radiography and packaging. The new plant manager is now first vice president of the Dayton Branch of the AES and has published technical articles.

Mr. Dearth has had more than 30 years experience in the plating field which includes some 19 years with General Motors.

●

GORDON O. WATSON, formerly assistant director of marketing for Carborundum's midwestern sales district, has been promoted to assistant director of marketing for the company.

Experienced in all phases of abrasives sales, Mr. Watson started with Carborundum in 1925 as a billing clerk and has progressed through sales promotion, direct selling, and district sales management to assistant director of the midwestern sales district with headquarters in Chicago, the position he held at the time of his recent promotion.

●

STANLEY P. WILMOT has been promoted to the newly-created position of operations manager, Waterbury plants of the Hubbard-Hall Chemical Co. In his new position, Mr. Wilmot will coordinate the activities of all non-office personnel and have over-all supervision of warehousing, manufacturing, delivery, and maintenance activities.

Mr. Wilmot has been with the Hubbard-Hall organization for 15 years. He started as foreman of manufacturing operations and later became chemical buyer in Hubbard-Hall's heavy chemical department. Mr. Wilmot was then appointed superintendent of Connecticut Chlorine Products, a wholly owned subsidiary of Hubbard-Hall, a position he held until his appointment as operations manager.

BRANCH NEWS

Total AES Branches U. S., Canada, Australia, January 1, 1960—58.

BLUE RIDGE
Theodore Voyda Speaks on Anodes

The Blue Ridge Branch met Nov. 6 at the Charcoal Steak House in Greensboro, North Carolina. **Bruce Wallace** presided. The membership of J. Aubrey Harless was announced. Mr. Harless is with Polyscientific, Inc., in Blacksburg, Virginia. **Theodore Voyda,** technical director, Apothecaries Hall Company, Division of Hubbard Hall Chemical Co. of Waterbury, Connecticut, was the speaker. The subject was "Anodes and Their Corrosion", covering discussion on nickel, zinc, copper, and chromium plating anodes, types, and effects on anode corrosion by chemical additions, impurities, and other physical considerations.

Robert H. Probert
Secretary

BLUE RIDGE
Dr. Leidheiser on Project 17

The Blue Ridge Branch met 5 December 1959 at the Elks Club in Roanoke Virgina with 23 ladies and gentlemen, from Greensboro and Winston-Salem, North Carolina, and Blacksburg, Roanoke, Bristol, Narrows, and Staunton, Virginia. Dr. Nelson F. Murphy presided. Dr. Henry Leidheiser Jr., Director of Research at the Virginia Institute for Scientific Research spoke on, "Microthrowing Power—A.E.S. Project 17", illustrated with color slides and blackboard.

Robert H. Probert
Secretary-Treasurer

BRIDGEPORT
Cavuto Discusses Dual Chrome Plating; Olde Timers Night Planned

The regularly scheduled business meeting and educational session was held at the Hotel Barnum on Friday, Nov. 13. President **Allen Ferguson** called the meeting to order. Thirty-six members and guests were present.

Mr. Ferguson introduced the guests, **Jack Ryan** of the Newark Branch, and **Vernon Burr, Dick Bikales** and **Pat Cavuto** of Metal & Thermit Co.

Two new members were accepted and presented with Branch membership certificates as well as Society membership buttons.

Charles Temple, chairman, added **Bob Parker** to his Olde Timers Night committee which also includes **Geo. Eckholm** and **Emil Bergen.** The date Feb. 17.

Al Ferguson reported on a New England Regional committee meeting which was held in the Hotel Statler, Hartford on Thursday, Nov. 5, 1959. He said that Messrs. **Logozzo, Barrett** and **Girard** were asked to serve as a committee to investigate the details of the 1961 Interim to be held in Hartford and report back to the Regional at the Jan. 7, 1960 meeting

A letter from the Springfield Branch asking for support of the candidacy of Bob Girard for third vice president of the Supreme Society was read.

Librarian Al Jocis introduced the featured speaker of the evening, Pat Cavuto of Metal & Thermit Co. Mr. Cavuto discussed the merits of Dual Chrome plating with all its attendant advantages and also compared its properties with that of Dual Nickel Plating.

BRITISH COLUMBIA
Panel Quiz on Finishing Problems

A general meeting was held on Wednesday, Oct. 28, at the Lougheed Hotel, Lougheed Highway, North Burnaby, B.C.

There were 19 members and guests, the meeting commencing at 6:30 p.m.

An application for membership was accepted.

The meeting was advised of the encouraging attendances at the night school course, and the apparent enthusiasm of both students and instructors. **C. Schlossareck** suggested that all plating shops could offer to contribute something in the way of a piece of equipment, or knowledge, to assist the school. This suggestion was well received, and brought immediate responses and offers of help from A.B.C. Plating, Stoneberg Bros. and Coast Laboratories.

A Panel Quiz on the subject of Metal Finishing Problems, was conducted by Chairman **Doug Armstrong,** and Board Members, **Walter Kellerman** and **Gordon Smith.** Small prizes were awarded members who in the opinion of the Board, gave either correct or nearly correct answers. This was a successful 40 minute period and it is hoped may be repeated later during the year. It proved both interesting and informative.

Doug Armstrong
Secretary

BUFFALO
Peacock Tells of Metals and Plastics for Plating Solutions

The Branch held its November meeting Friday, Nov. 6 at the Niagara Manor in Buffalo, N. Y. with 24 members and 3 guests in attendance.

Harold Shapiro, our first vice president, introduced the guests and gave a report on the status of Branch membership.

After the business session Librarian **Dick Davis** introduced the speaker of the evening, **James H. Peacock** of the Duriron Company, Inc. who spoke on "Metals and Plastics for Handling Plating Solutions". **Robert Fooksman,** local representative of the Duriron Co., assisted the speaker.

The February meeting will be held Friday, Feb. 8, 1960 at our regular meeting place. **Christopher Morzano,** chief chemist of the Amphenol-Borg Electronics Corporation will speak on "How to Plate Difficult Metals."

Robert E. Lienert
Secretary

CHICAGO
Weisberg and Jacobsen Speak on Gold Plating

The regular monthly meeting was held Friday, Nov. 13, at Stella's Restaurant, 3206 North Kostner Avenue. In spite of the inclement weather, a good turnout of members were present. Five applications for membership were turned over to the board of managers for approval.

The 48th Annual Education Session and Banquet will be held on Saturday, Jan. 30, 1960, at the Conrad Hilton Hotel. The educational session will begin at 2:00 p.m. and the panel will be **Cleve Nixon,** General Motors; **Joseph Gurski,** Ford Motor Company and a representative from the Chrysler Corporation. Cocktails will be served from 6:15 to 7:15 p.m. and the banquet will start at 7:30 in the grand ballroom. Frankie Masters and his orchestra will furnish the music for the floor show and dancing till 1:00 a.m.

The First Annual Conference of the Midwest Regional Council which was held on Saturday, Nov. 7, at Rockford College in Rockford, Illinois, was indeed a success! **Dr. William Blum** of Washington, D. C., was guest speaker at the luncheon and his subject was "Education and the Electroplating Industry." **Simon P. Gary,** librarian, introduced the Chicago Branch speakers, **Al Weisberg** of Technic, Inc., and **Eric Jacobsen** of James Plating Works. Their subject was "Precious Metal Plating Today." Mr. Weisberg

BRANCH SECRETARIES

Branch News is required of all Secretaries monthly by AES Bylaws. First of the month is Branch News deadline for next PLATING issue. Any items on hand on that date will be carried in that edition. Later arrivals will appear in the issue immediately following. In reporting talks given by speakers before the Branch, please give titles of the talks, the speakers' full identification and any other pertinent information of interest to other Branches and PLATING's broad readership.

INDICATE A 143 ➤

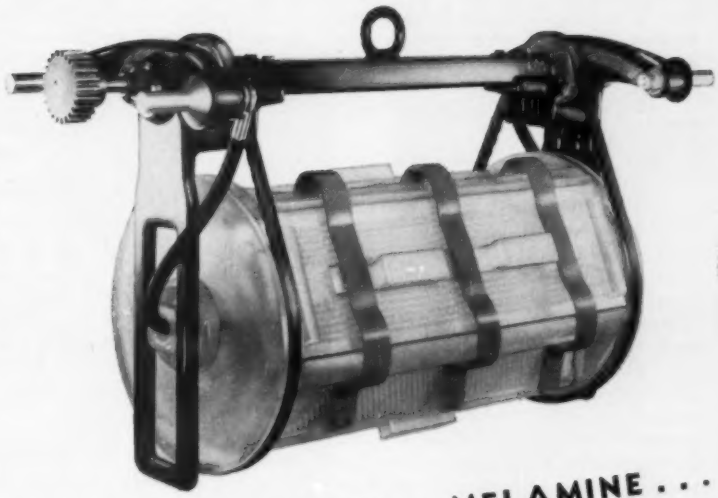
The NEW STUTZ Plating Barrels

Low headroom design
New materials

Stutz complete cycle assembly for operation in tanks with driving mechanism located externally. Lifting and lowering of unit reduced to a minimum. Cylinder is totally submerged in operation. Belt drive is positive timing design and belts can be changed if necessary in seconds without tools. Saddle horns are located on 15" centers. Cathode contactors dangler type standard, other types available. Cylinder hangers are cast steel protected with special hard rubber or fused vinyl chloride.

Cylinders can be supplied in special sizes, partitions if necessary and special cathode contactors as required.

Barrel assembly units are made to fit all makes of tanks.



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Cylinder rotation in this design is provided by motor drive mounted directly in super structure bridge member. Total weight and overall height has been greatly reduced. Handling therefor is fast and smooth. Cylinder transported from one operation to the next under continuous rotation. In this manner solution dragout is reduced to a minimum. Rinsing time following alkali cleaning, acid pickling, etc., is greatly reduced. Overall dimensions of tanks is lessened by the elimination of motor drive platform. Electric service 440, 220, or 115 volt with grounded cable and Hubble-lock heavy duty safety connector.

Sizes 12" to 18" inside diameter—24" to 42" long—perforations 3/32" standard. All other sizes available.

Tanks in single and multiple—Power equipment — dryers — filters — heat exchangers — chemicals — anodes — ventilation, etc.

Barrel assembly units are made to fit all makes of tanks.

STUTZ *Portable Plating Barrels*

The Stutz Portable Barrel is made in 3 standard sizes with cylinders having inside dimensions of 6"x12", 8"x18" and 10"x20" I.D. Smaller upon application. Standard openings are 3/32". Smaller or larger openings can be furnished as required.

- **Baskets in perforated metals or wire mesh.**
- **Load/Unload Stand for convenient and fast handling of work load.**

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spoke on the applications of gold for (1) missiles (2) printed circuitry (3) electrical contacts and (4) decorative plating. Mr. Jacobsen discussed decorative and industrial (specification) gold plating.

Christopher Marzano
Publicity Chairman

CINCINNATI
Brush Plating Presented by Rubenstein and Van Cowger

Thirty-six members and guests met at the Engineering Society Headquarters on Oct. 28 to hear a discussion on "Selective Localized Plating", better known as "Brush Plating". Due to the illness of **Phil. Brotzman** of Ohio Metachemical Co., Marvin Rubenstein of Marlene Development Co., Inc., and **Mr. Van Cowger** of Sifco Metachemical, Inc., presented the program for the evening. It was pointed out that there has been much research and development work done on "brush plating" in recent years. Major advancements which have been made are: "brushes" and special solutions. Brushes are available in many shapes and sizes, and solutions are available to plate almost everything that can be done in "bath process". At the present time there are over 200 applications of brush plating being used in industry. Demonstrations of plating nickel and chrome on steel, nickel on aluminum, and tin on steel were conducted. Slides on some of the applications were shown and a question and answer period ended the meeting. The group adjourned to the social hour sponsored by the Wm. Buchanan Supply Co., **Bill Buchanan** and **Willis O'Brien** as hosts.

D. L. Kaplan
Secretary

CINCINNATI
Kubis on Aluminum Cleaning Etching and Deoxidizing

Thirty-six members and guests met at the Engineering Society to hear Mr. E. J. Kubis of the Wyandotte Chemicals Corporation talk on Aluminum Cleaning, Etching and Deoxidizing. The speaker used slides to augment his discussion. Mr. Kubis explained the different methods of cleaning that are available and pointed out applications of the various methods. Methods for removing buffing compounds were discussed. Mr. Kubis closed his talk with the factors affecting the etching of aluminum and the methods used to prepare aluminum for plating and enameling.

Paul Profitt and Robert Queenan were elected as members of the Cincinnati Branch. Dave Kaplan gave a report on the progress on the 1960 Tri-State Meeting to be held in Cincinnati.

D. L. Kaplan
Secretary

CLEVELAND
Dr. Faust Guest Speaker

The Cleveland Engineering and Scientific Center was the site for the October meeting. Following a welcoming dinner for the guest speaker of the evening, the branch librarian, Mr. George Shepard, introduced Dr. Charles L. Faust of Battelle Memorial Institute.

Dr. Faust's excellent presentation of his subject "Surface Metallurgy Aspects of Metal Finishing" was most enthusiastically received by nearly one hundred members and guests. An interesting question and answer period followed.

Thereafter, a short business meeting was conducted by president John Winters.

John Gade
Assistant Librarian

COLUMBUS
Washburn Discusses Stripping of Coatings

This monthly meeting was held at Battelle Memorial Institute with 20 present. The meeting was called to order by President **Marvin Pingel.** The Cincinnati report on the Tri-State Meeting was discussed. One new applicant was elected to membership.

Librarian **Hugh Miller** introduced the guest speaker of the evening, **Edward**

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B. Washburn of Enthone, Inc., New Haven, Conn. His subject was "Stripping of Electrodeposits". He gave a detailed account of the chemical compositions and operating conditions of strippers for the entire gamut of electroplated coatings. During the subsequent question period he offered solutions to several specific problems posed from the audience. The meeting was adjourned, and refreshments were served through the courtesy of the Diamond Alkali Co.

Leslie D. McGraw
Secretary

COLUMBUS

Cleaning Metal With Sonic Waves

This monthly meeting was held on December 4 at Ricardo's Restaurant. The meeting was called to order by Marvin Pingel, President. The Secretary's report was read and approved.

A report on preparations for the Tri-State meeting to be held in Columbus resulted in a motion that the Tri-State meeting be scheduled for February 4, 1961, with the prior week as an alternate. The motion passed.

Librarian Hugh Miller introduced the speaker of the evening, Mr. Bruce Young, Manager of Marketing Development at Detrex Chemical Industries, Inc., Detroit, Michigan. Mr. Young spoke on "Cleaning Metal with Sonic Waves." His description of the use of this cleaning method, coupled with detergents or chlorinated solvents, to remove finely divided residues or smut from metal parts was well illustrated with slides and an interesting demonstration.

L. D. McGraw
Secretary

DAYTON

Clinehens and Myer Give Papers; Tour Cash Register Plant

The Dayton Branch inaugurated its program for the season on Sept. 23 with a meeting at the National Cash Register Co.

Richard M. Clinehens, project engineer of NCR and Dayton Branch secretary, explained the properties of magnetism, types of alloys plated and the application of these alloys in a fine paper entitled "An Introduction to the Plating of Magnetic Alloys".

Following Mr. Clinehen's talk, a tour was made of some of the research laboratories where facilities were shown for research work on porous rubber, NCR paper, check sorting, photochronism, powdered metals, ductile iron, magnetic ferrites, and specialized electroplating.

The evening was concluded with a question and answer period and refreshments served in the cafeteria.

The October meeting was held on Oct. 21 as a dinner meeting at the Yum Yum Restaurant. During the business meeting, **Holle Luechauer** presented the minutes

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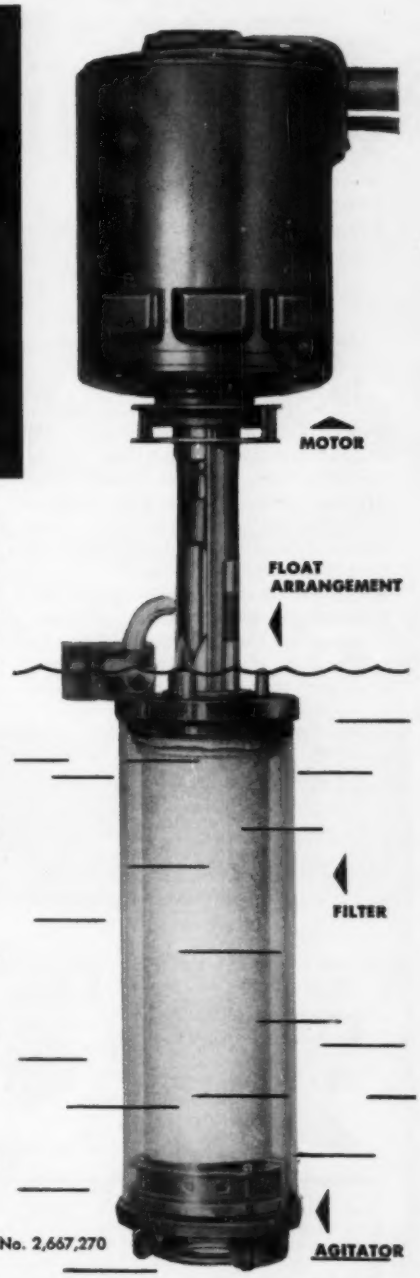

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of a meeting of the Tri-State Committee of the Cincinnati Branch. These minutes mentioned a proposal that admission fee be charged for the educational session. The Dayton Branch instructed its Tri-State delegates to vigorously oppose such action.

The speaker of the evening was **J. R. Myer** of the Materials Laboratory, Wright Air Development Center. He discussed the application of various coatings for the protection of substrates above 2000F. Ceramic coatings have been the most successful to date. The talk was illustrated with a color movie.

L. A. Critchfield
Publicity Chairman

DENVER

Saltonstall on Uses of Agitation, Anderson on Barrel Finishing

The Denver Branch meeting was held on Nov. 13 at the Mine and Smelter Supply Co., 3800 Race Street. The regular meeting was preceded by an executive board meeting. President **Bob Martin** announced that **Phil London** had submitted his resignation as secretary. **Elmer Schuster** was appointed to fill the unexpired term. The application of a new member was presented to and accepted by the board of managers. The regular business meeting followed.

The first of two speakers, **Randy Anderson** of the Norton Co. gave a talk on barrel finishing. He presented a short history of barrel finishing. Then with the aid of slides explained the use of different types of barrels, and application of different types of barrel finishing media. Following a short recess **Dr. R. B. Saltonstall** of the Udylite Corporation presented a talk on different types of agitation and their use in cleaning and electroplating processes. Detailed information was given on the use of air agitation in modern bright nickel plating.

DENVER

Millet Presents Paper

The December meeting of the Denver Branch was held at the Oxford Hotel on December 4, 1959. The meeting was called to order by Duane Poucher, 2nd Vice President in the absence of Robert Martin, President who was attending the Aerospace Finishing Symposium in Texas.

After a short recess Mr. Tom Millet of the Allied Chemical Corporation, General Chemical Division presented a paper on the use of fluoboric acid and fluoborate solutions in the electroplating industry. Of interest was the high plating rate of copper fluoborate solutions in plating wire and rotogravure rolls. The corrosion resistance of lead plated from fluoborate solutions was also stressed.

Elmer A. Schuster
Secretary

DETROIT

About the Ladies

Maybe the ladies would like to know what goes on at our Detroit Meetings, so here goes.

At the September meeting we plugged for the California convention by having Mr. W. Fudge of United Air Lines show some really wonderful, colored pictures not only of the fair city of Los Angeles but right up the state to San Francisco, answered a lot of questions, had our auxiliary on the edge of their seats spellbound and as the saying goes practically drooling at the mouth. And congratulations for the exciting articles published in PLATING since June concerning this Los Angeles Convention.

We have started celebrating members birthdays and a mystery drawing, presented with an address-o-graph by our Alice in Wonderland, **Mrs. George Pillsbury** who also donated the first mystery gift.

October meeting; the president used our new auxiliary gavel for the first time, reports were given by various committees, finance, membership, special wants and program.

A very special event will take place in April (we hope) at this time do not care to divulge, you are correct, I love to keep you in suspense.

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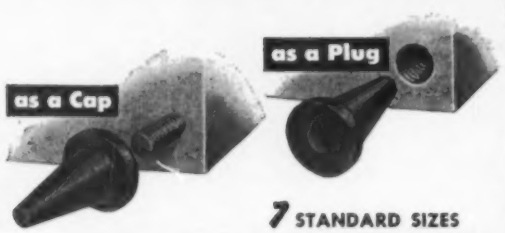

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ROHCO 503 STILL OR BARREL ZINC BRIGHTENER (LIQUID)—produces jewel-like bright zinc deposits; ideal where one brightener is desired for all your bright zinc baths.

ROHCO 100 AND 100 SPECIAL BARREL BRIGHTENERS (LIQUID OR POWDER)—the most widely used of all barrel zinc brighteners; brilliant, bluish deposits directly from the plating tank.

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ROHCO 150 (POWDER) AND PERMA-BRITE B-150 (LIQUID) BARREL BRIGHTENERS—the most economical barrel brighteners on the market; for maximum brightness a bright dip is required.

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ROHCO ZW-600—wetting agent for cyanide zinc baths. Eliminates scum on the surface, lowers drag-out, and improves plating bath operation in both barrel and tank.

ROHCO ZINC-SOL—double strength, purified make-up or replenishment solution for instant bright plating.

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RODIPS—short-dip chromate treatments supplied as powders to brighten, passivate, and protect zinc plate for improved corrosion resistance and color retention. Receptive to subsequent absorption of dyes for color identification of parts.

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ROHCO 20XL and SUPER XL (LIQUID OR POWDER)—tops for producing the clearest, brightest barrel, or still cadmium; minimizes cadmium usage by improving uniformity and speed of deposit.

RODIP CD-3 and CD-4—single short-dip chromate post-plating treatment without leach for brilliant cadmium and good corrosion protection; CD-3 for automatic tank or barrel, CD-4 for manual operations.

CAD-SOL—a heavy solution of cadmium cyanide for easiest bath make-up or maintenance.

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ROHCO ANTI-SPRAY—produces foam blanket which eliminates chrome mist, safe for hard chrome baths.

ROHCO SUPER NO-CRO-MIST®—safeguards workers' health by eliminating chrome fumes, solves ventilating and heating problems; saves chromic acid.

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ANODICATOR THICKNESS TESTER—an approved, new instrument for electrically checking thickness of anodic coatings. Completely automatic.

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RECTIFIERS—for Hull Cell tests and/or plating operations. Complete range of capacities from 5 amperes up, with output to give 5% or less ripple. Optimal automatic timers for 5 to 50 ampere units.

HULL CELLS—used world-wide for control of plating baths. Porcelain or molded polyethylene in 267 ml. capacity. Clear lucite in 267 ml. and 1,000 ml. capacities with or without heater and thermostat.

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Mrs. Betty Matoff, proprietor of Riverside florists, Detroit, and her assistant demonstrated several floral arrangements which were very interesting, Betty was our florist at the convention.

This was followed by a 20-question quiz led by **Mrs. Evelyn Ben** our most capable program chairman, as names were pulled from a hat the contestant had to answer correctly a question on electroplating, she then received one of the floral arrangements, sure was a lot of fun and very educational, surprising to find out how much knowledge our ladies have on plating.

How about it gals? If you don't think we have fun come and join us any meeting night 8 p.m., Statler Hotel, the first Friday of each month.

Wonder how many of you read **Dr. W. A. Wesley's** (first vice president) formula for success in the October issue of PLATING. I assure you it was very interesting plus very true, congratulations Dr. Wesley, and please let us have some more.

To **Mr. Ben Sax,** who really puts a very good point across every month a big thanks, keep it up Ben.

To the rest of the AES, won't you pass the word around, if you read PLATING you know what's going on.

Edna Heavens
Magazine Publicity
Ladies Auxiliary

HAMILTON

New Plating Course, Cranfield Donates Proceedings

Meetings are being held during the 1959–1960 Season at the Fischer Hotel, York and Park Streets, Hamilton, on the third Friday of each month at 8:15 p.m.

The committee for this term consists of **K. J. Taylor,** president, **C. R. MacLeod,** vice president and corresponding secretary, **D. Moss,** publicity secretary, **Wm. Makison,** treasurer, **A. Lee,** librarian and **R. Harrison,** Organic Division chairman.

Our program for the year includes speakers and films on organic finishing, as well as electroplating.

Last year a course in electroplating was started by the Branch. Thirty-eight persons registered for this twelve week lecture period and demonstration series; 25 persons passed the examination.

This year, a 26-week course is under way which involves laboratory plating as well as lectures; lecturers are **G. J. Needham** and K. J. Taylor.

A generous donation of Proceedings, 1949 to 1957 inclusive, was made by **E. K. Cranfield** to our Branch. They are at the Main Branch of the Hamilton Public Library.

K. J. Taylor
President
C. Ross MacLeod
Secretary

HARTFORD

MacIntosh Presents Tin Plating

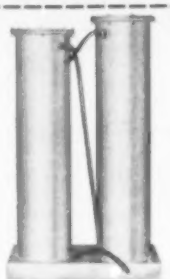
The regular Branch meeting was held at the Veterans of Foreign Wars building on Oct. 19 and 42 members and guests were present.

The guest speaker for the evening was **Robert M. Mac Intosh** of the Tin Research Institute, Inc., whose subject was "Tin and Tin Alloy Plating".

Tin is non-toxic, it is soft and pliable and not too corrosive. Its largest use is in plating steel for tin plated cans and the next largest user is the electronics industry for ease of soldering. The following baths were discussed: the alkaline sodium or potassium stannate baths, acid tin fluoborate for plating wire, stannous sulphate and the high speed fluoride bath. Bath formulations were mentioned in detail. The alkaline bath has good stability and good throwing power and its disadvantages are that anode control is critical, must be heated and has poor efficiency at high current density. The acid stannous bath has almost 100 per cent efficiency, requires no heat and high current densities may be used. Some disadvantages are that a rubber lined tank must be used, control is difficult and sludge forms. Addition agents as well as the bright tin bath was mentioned. Various alloys of

M1

Will produce 1000 gallons or more of pure water between regenerations. Flow rate: 5 gallons per minute.



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Carma De-Mineralizers assure low investment and operating costs while removing all ionizable impurities, including C_2O and silica.

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- **Recovery of metals (chromic acid)**
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SEYMOUR PCN®
Stress Reducing Agent
is YOUR ANSWER!

The average Watts solution . . . without any stress relieving agent . . . will deposit nickel having a tensile stress of 23,000 psi and a hardness of 150 VHN. The addition of Seymour PCN in proper amounts will convert this tensile stress to a compressive stress thus depositing a nickel which tends to hug the base metal. Further, the degree of compressive stress can be controlled through a range from zero to 8,000 psi! The hardness of the nickel deposit increases from 150 VHN to 600 VHN without any loss in the high ductility characteristic to all Seymour plating solutions.

Other PCN Characteristics:

- Nickel deposits of high chemical purity.
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- No breakdown or formation of organic contamination.
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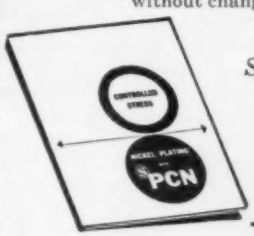

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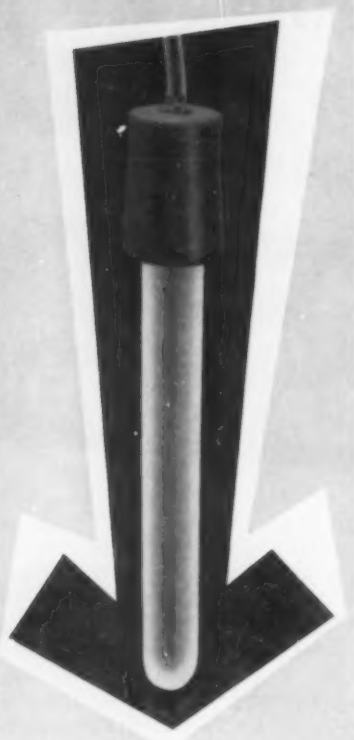

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tin as with copper, zinc, cadmium, lead, nickel, etc. were mentioned and slides were shown on corrosion test panels on tin-zinc and tin-cadmium alloys.

The technical chairman for the evening was **Edwin Crandall.**

Stanley Platoz
Secretary

HARTFORD
Dr. Murphy of VPI Speaks at Nov. Meeting

The regular Branch Meeting was held at the Veterans of Foreign Wars building on Nov. 16 and 47 members and guests were present. Preceding the meeting an interesting color movie was shown.

The guest speaker for the evening was **Dr. Nelson Murphy** of the Virginia Polytechnic Institute, whose subject was "Electrodeposition In Non-Aqueous Solvents and Molten Salt Baths".

The following are some of the reasons Dr. Murphy mentioned why metals are deposited from non-aqueous or molten salt baths: some metals are more active than hydrogen, hydrogen is codeposited, components react with water, components are insoluble in water, metals are non-conductive at low temperatures, metals are self-polarizing, furnish thermodynamic and physical information and special methods of compound preparation. Theoretical explanation and the mechanism of how metals are deposited from molten salts and solvents other than water were discussed. Various baths were discussed on plating Aluminum from organic solvents and the deposition of aluminum, bismuth, boron and molybdenum from molten salt baths were covered.

The technical chairman for the evening was **Art Logozzo.**

Stanley Platoz
Secretary

INDIANAPOLIS
Delco-Remy Plant Tour

Members of the Indianapolis branch of AES were guests for dinner of the Delco-Remy plant at Anderson, Indiana on Monday, Nov. 2. The dinner was served at Don's Barbecue on the By-pass at Anderson. Forty-eight were present. Fried chicken and barbecued ribs with all the trimmings were served. **Robert Kessler,** Delco-Remy works manager and a former Purdue all-star athlete was present at dinner and welcomed us. He told us briefly about automotive electric equipment made by his company. They have 14 plants of which ten are in Anderson and these ten plants employ 15,000 persons. Mr. Kessler told us about their zinc plating set-up which turns out 3,200,000 pieces per day. The program for evening was a tour through plant No. 10.

A short business meeting preceded the tour. Two applicants for membership were presented. **Les Reynolds,** president, read a letter from the National Office about the new sustaining membership taken out by Western Electric Company.

A vote of thanks was given to **Max Bahler** and all the Anderson members for planning such a nice evening for us.

At 7:30 p.m. the group drove to plant 10 where guides met us and explained the many operations of Delco-Remy.

Edna Rohrabaugh
Secretary

LOUISVILLE
Ladies Night Program Enjoyed

The October meeting of the Louisville Branch was the annual ladies night program. All formal business was suspended. Librarian **Harlan Bowsher** arranged for square dancing and over twenty members and guests were on hand with their wives and dates. **Frank Lamping** arranged for the use of the Richmond Boat Club and the fine dinner. The dancing went on long into the evening and a wonderful time was enjoyed by all.

K. C. Reifsteck
Publicity Chairman

LOUISVILLE
Dr. Taylor & Ken Bennett Guest Speakers

The regular meeting of the Louisville Branch was held on Thursday, November 19, 1959 at Hasenour's Restaurant with thirty (30) members and guests present.

After a roll call of officers, an introduction of our guest speaker, Dr. A. Lloyd Taylor, was made.

Delegates for the National Convention are to be the same as last year.

Mr. Ken Bennett, of the Universal Button Company, was our speaker for "Industry Night." He gave a very descriptive talk of their operations and products.

Our guest speaker, Dr. A. Lloyd Taylor, MacDermid, Inc., was introduced by Harlan Bowsher. Dr. Taylor gave a very interesting lecture on metal cleaning prior to electroplating. His talk included discuss'on of soaps and their cleaning methods, detergents and their clean'ng methods, the differences of silicated and phosphate cleaners and much other information on the selection of the proper cleaner for the particular soil or soils to be cleaned.

A short "Question and Answer" period followed.

K. C. Reifsteck
Publicity Chairman

MISSISSIPPI VALLEY
Winsman Speaks on Abrasive Belts

The November 18 meeting was held at the Moline Legion Hall, Moline, Ill. After the customary speakers dinner the meeting was called to order by president **Dennhardt.**

M&T **News about COATINGS FOR METALS**
from Metal & Thermit Corporation

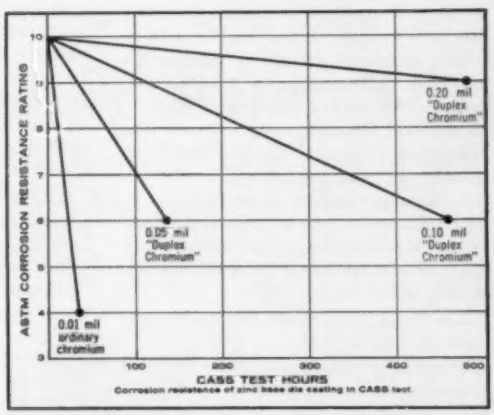
How to get the optimum protection of bright chromium plating

There are three requisites to increasing corrosion protection from chromium plating. (1) The deposit must be sufficiently thick. (2) There should be a crack-free chromium base topped by a special, finely cracked chromium deposit. (3) The plate should be more uniformly distributed over the part, so that recessed areas, too, are assured at least 0.03 mils minimum chromium thickness.

All of these requirements are easily met through UNICHROME SRHS® CHROMIUM plating processes. Work done for the automotive industry, long plagued by corrosion of brightwork in outdoors exposure, provides a good case in point.

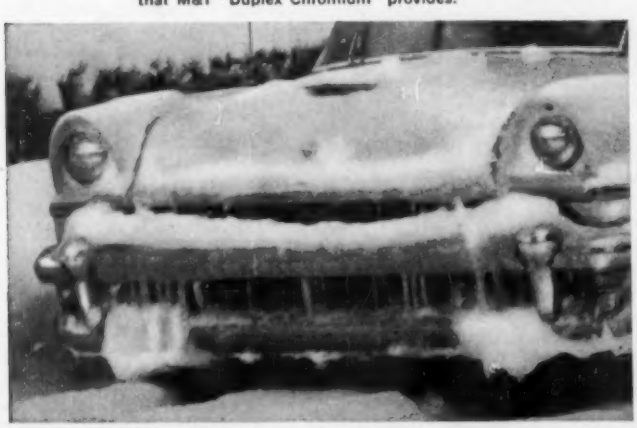
AN ANSWER TO OUTDOOR CORROSION

Note the results in the chart at right. In all cases, the thickness of undercoats was kept constant. Only the chromium plate was varied... from ordinary to "Duplex", and progressively thicker. M&T "Duplex Chromium" calls for first using Unichrome Crack-Free Chromium and its ability to throw into recesses and give a more uniform and fracture-free plate. This is followed by another deposit of Unichrome SRHS Chromium, with its *controlled* cracking. With increasing thickness, the protection increased tremendously. Durability as determined by rigorous, accelerated corrosion testing techniques was multiplied as much as *20 times.*



Zinc die cast specimens, all plated with 0.75 mil copper and 0.75 mil nickel prior to chromium lasted as shown above in the severe CASS test (Copper accelerated acetic acid salt spray). Ordinary chromium fared poorly. Optimum protection was approached by using Crack-Free Chromium and increasing the deposit thickness.

Despite severe service conditions, automotive brightwork can stay bright now, due to the additional corrosion protection that M&T "Duplex Chromium" provides.



WIDELY USEFUL FINISH

While the above case concerns itself specifically with an automotive problem, it indicates what thicker chromium in general, and crack-free chromium in particular can do for other design problems involving corrosion and wear. This plate blocks infiltration of corrosives to underlying metal.

Technical Papers giving full details on the advantages of thicker chromium deposits are available for the asking. Write METAL & THERMIT CORPORATION, Rahway, New Jersey.

M&T **plating products**

METAL & THERMIT CORPORATION
General Offices: Rahway, New Jersey
In Canada: Metal & Thermit – United Chromium of Canada, Limited, Rexdale, Ont.

President Dennhardt appointed **Arthur Jackson** and **John Miller** to act as the committee for the annual Ladies Night to be held Dec. 19.

Vice President **Wilber McKay** introduced the speaker for the evening, **R. E. Winsman** of the Behr-Manning Co. whose subject was "Better Offhand Polishing with Coated Abrasive Belts". After a movie on the subject Mr. Winsman answered many questions from the floor.

Clyde Shepherdson
Secretary

MONTREAL

Carroll Speaks on Acids; Problem Night Planned

The regular monthly meeting of the Montreal Branch was held at the Sheraton Mount Royal Hotel on Nov. 9.

Our president called the meeting to order at 8:45 p.m. with 24 members present. Mr. **Takeuchi** then called upon Librarian **J. Saimoto** to introduce **J. W. Carroll** of Pennsalt Chemical Corp., our speaker for the evening. Mr Carroll showed some excellent slides and gave a very informative talk on Inhibited Acids in the electroplating cycle. Mr. Carroll was thanked on behalf of the Montreal Branch by **E. Kynnersley.**

The Branch welcomed two more new members into the fold.

Bruce Millward, dinner dance financial chairman, read a statement on the dinner dance and it was approved unanimously by the members.

It was also planned to have a problem night in February or March when members could present their plating problems to the floor and they would try to be solved.

The Secretary was instructed to contact other branches in Eastern Canada and the States to see if a sufficient number of members can get together and charter an aircraft for the trip to the Los Angeles Convention in 1960 and return.

R. W. Niggemann
Secretary

NEWARK

Du Fosse on Job Shop Plating; Panel Discusses Specifications

During the Oct. 16 business meeting, eight applications were received and five were elected to membership.

The membership approved a dues increase to $12 per year, the incorporation of the Branch, and a contribution of $25 to the local Red Cross. **John Banta** reported on membership and Christmas Party activities and **Cy La Manna** on the Electroplating School plans for 1960.

Librarian **Al Korbelak,** introduced the Timely Topic speaker, **Bill Du Fosse.**

Bill's subject was "Job Shop Plating—Its Challenge and Rewards" and he noted the challenges as competition, maintenance of quality and standards. He stated better cost methods should be developed and each shop should specialize to some extent. Bill also noted that each job shop owner had to meet the challenges of diversified use of equipment and planning for the future, both equipmentwise and processwise. He concluded by saying that the challenges themselves were rewarding as was the fact that jobbing offers more freedom of action, changes are easier to make, and finally, monetary rewards are possible.

Librarian Korbelak introduced a panel, consisting of **Marty Maher** of Oakite Products, **Gus Mendizza** of Bell Laboratories, **Dr. Karl Schumpelt** of Sel-Rex, and **Dr. Frank Dudley** of Franklin Manufacturing Co. who discussed "Specifications and Tests."

Mr. Maher discussed the scope of a specification and pointed out that the objectives must be valid. Marty referred to surface preparation specifications as he developed the general theme, which included a discussion of tests required to determine whether the requirements of the specification had been met.

Mr. Mendizza discussed plating specifications as set up by Bell Laboratories, pointing out that the prime criterion was: "How does the part perform under service conditions—not the process used." He pointed out that one of the great difficulties was the fact that accelerated tests leave much to be desired. He further stated that the specification of plating thickness was not enough, but that corrosion, porosity, wear, etc., should be specified when they are factors controlling the extent of service required of the part.

Dr. Schumpelt, having lost his voice during the day, asked **Mrs. Grace Wilson** to present his paper on "Microhardness and Thickness of Electrodeposits." It was pointed out that microhardness techniques could not be applied indiscriminately to microhardness measurements; that the measurement should be made on the cross-section and, therefore, the thickness should be 0.001 in. or more, otherwise there is danger that the base metal hardness is being measured. In any event, time of descent of the diamond, size of load and time indentor rests on the sample should be reported. With regard to thickness determinations by microscopic methods, it was stated that accuracy in the range of 10 millionths is impossible. Even at 40 millionths, errors of five per cent and more are possible, so that thicknesses of less than 0.00004" should not be reported.

Dr. Dudley concluded the panel discussion by describing new platinum plated titanium anodes he has developed for galvanic corrosion protection and the method of testing these anodes using seawater in contact with base metals.

Following a short question-and-answer period due to the lateness of the hour, the 80-odd members present enjoyed refreshments while chatting about general electroplating subjects.

D. Gardner Foulke
Secretary

NEWARK

Topics by Abrazio; Tilton Talks on Plating Racks

President Meyer called the meeting to order after the movie ("What's a Silicon") with 56 in attendance on November 20.

Dr. Foulke announced the Products Finishing Competition and the Aerospace Finishing Symposium to be held in Fort Worth, Texas. John Banta reported on the Christmas Party and Cy LaManna on the Electroplating School.

Al Korbelak then introduced Ray Abazio whose Timely Topic was Phosphate Coatings. He listed the types of coatings and pointed out the principle uses for each type. Ray concluded his talk by pointing out applications for phosphoric acid pickling cleaners.

Herb Tilton then discussed in detail the "Engineering and Design of Plating Racks". By means of colored slides the speaker pointed out the methods of fabrication of racks and engineering considerations and concluded by showing a great number of special racks for particular applications.

D. Gardner Foulke
Secretary

NEW YORK

Cavuto Talks on Barrel Plating

The Oct. 9 meeting was called to order by President **Joseph Rembecki** and called on **Angelo Amatore,** one of our delegates, who gave a report on The National Convention. He informed the Branch that New York was selected for the 1965 Convention.

Librarian **Martin Pollack** introduced **Patrick Cavuto** sales engineer for Metal and Thermit Corp. Mr. Cavuto, with the aid of slides covered the development of "Barrel Chromium Plating." He described the various barrels developed in this country and the continent and the disadvantages which prevented their widespread adoption by the plating industry. For years there was very little progress in barrel chromium, but lately a number of improvements in the plating solutions and the barrels are making them acceptable for regular production.

Fred Saras
Recording Secretary

NEW YORK

Rectifiers Discussed by Chait

President **Joseph Rembecki** presided at the Oct. 23 meeting.

Two new members were unanimously elected and duly sworn.

Al Fusco moved to set aside a page in the minutes in memory of the late **Jule T. Davis** of Davis K. Products Inc. A minute silence was kept in memory of the deceased member.

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Model 20 New Holland KREIDER Centrifugal Dryer

Air-dries . . . as it Spin-dries! Eliminates scoring and marring . . . speeds up production . . . cuts down on rejects!

SPECIFICATIONS:
1-h.p. motor—220, 440, 550 volts—2 or 3 phase. Spins 75-lb. loads at 825 r.p.m. Quiet V-belt drive. Arc-welded steel plate construction. Weight 490 lbs. Requires minimum floor space. Meets N.E.C. specs. Auxiliary electric or steam heating units available as optional equipment.

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. . . sent or brought to you by our representative on request. Specify metal, type of wheel and operation.

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JANUARY 1960 USE READER SERVICE CARD; INDICATE A 157.

NEWS from

Dresser Electric Co.

TYPE "LS" SILICON DC POWER SUPPLIES

Standard units now incorporate the very latest developments in Silicon Diode Design. Deliver full rated current at rated voltage day in and day out. Accurate regulation—full overload protection—low ripple.

SINGLE PHASE BENCH MODELS

120 Volt, 60 Cycle AC Input

25, 50 and 100 Amp

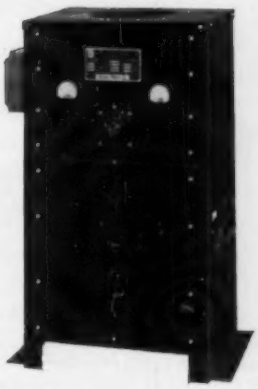
6, 12 and 18 Volt DC Output

3 PHASE FLOOR MOUNTED MODELS

230 or 460 Volt, 60 Cycle AC Input

100, 200 or 300 Amp

6, 12 and 18 Volt DC Output



Also available with remote control.

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For complete information write today for Dresser Catalog LS. For units 500 Amps and up, ask for Catalog HS.

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WHY GUESS ?

MEASURE PLATING THICKNESS

to a millionth of an inch

Your profits depend on meeting tight specifications, maintaining quality control and reducing rejects. Can you afford to guess at plating thickness when it is so easy to *measure and be sure*?

UNITRON'S PL-MEC PLATER'S MICROSCOPE substitutes facts for uncertainty. The plated deposit is observed through a Filar Micrometer Eyepiece and measurements are read directly from a micrometer drum. This compact microscope is easy to use, portable around the shop and has a built-in light source. It also doubles as a metallurgical microscope for examining grain structure etc. at magnifications of 25X-1500X. Permanent photographic records may be made using an accessory 35mm. camera attachment and provide valuable legal protection for subcontractors.

UNITRON'S PLATER'S MICROSCOPE will save its initial cost many times over. Prove this for yourself — as so many firms in the plating industry have done—by requesting a **FREE 10 DAY TRIAL** in your own plant. There is no cost and no obligation.

Above: Accessory camera attachment. Left: Observing the plated deposit.

$468 Model PL-MEC complete with all optics and standard accessories	As above with built-in camera attachment, but without 35mm. camera back: **$540**

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Report was made on the coming banquet to be held at the Hotel Statler Feb. 2. Three speakers will present papers during educational session. There will be a cocktail party preceding the banquet.

Motion made and carried to cast a ballot of one in favor of convention delegates Joseph Rembecki, **Milton Nadel, Angelo Amatore** and alternates **Arthur Carlson, George Herrmann** and **Phil Bruno.**

Next meeting is to be a summons meeting to vote on recommendations of the board to raise dues to cover increase on per capita tax.

Librarian **Martin Pollack** introduced **S. Chait** of Macarr Inc. Mr. Chait gave a wonderful talk on "Power Control of Rectifiers". He gave a lesson on principles of electricity for plating to the members after which he explained ways of controlling the voltage at the tank. On the blackboard he explained theories used and by means of equipment gave a very good demonstration. He applied various mock loads on the line and showed on the meter that even though the voltage varied at the rectifier, on the tank the voltage remained the same, though the loads were changed. By the number of questions asked and the discussions, we must say that Mr. Chait's subject was well presented and greatly appreciated by the members.

Fred Saras
Recording Secretary

NEW YORK
Paper on Coordination Compounds and Chelates Given

President Joseph Rembecki called the Nov. 13 meetmg to order. Roll call at the Hotel Statler, all officers were present. Mmutes of previous meeting, Oct. 23, read and accepted.

There will be only one meeting in December, to be held the second week on Friday the 18th. It will be our Christmas Party and there will be refreshments served.

Motion made and carried by a unanimous vote to raise our Branch dues to $15.00 a year to cover increase in Per Capita by the National Society.

All further business was dispensed with and Librarian Martin Pollack took over for "Good and Welfare". Martin introduced Mr. Lionel De Walthoff, Technical Director of Octagon Process Inc. Lionel's paper on "Coordination Compounds and Chelates" was very well presented. The paper and discussion were appreciated by the members present since subjects are thoroughly used in the plating industry.

Fred Saras
Recording Secretary

PHILADELPHIA
Beckwith Explains Duplex Nickel

The Branch's regular meeting was held on November 23 at the Engineers' Club with 38 at dinner and about 75 at the meeting. Following introduction of guests, Librarian Berenato introduced Dr. M. M. Beckwith, Harshaw Chemical Company, whose subject was "Application and Advantages of Duplex Nickel."

Studies were made in 1953, he said in part, on the comparative corrosion resistance of bright nickel, buffed Watts nickel, semi-gloss buffed nickel and semi-gloss bright nickel duplex coatings. It was shown that less basis metal corrosion products were produced by the duplex coatings on zinc die castings and steel, with defects limited to some surface pitting. Dr. Beckwith stated that the superior corrosion resistance of the duplex nickel was believed to be due to no sulfur being present in the deposits. Studies made with sulfur-containing and sulfur-free nickel coatings on test panels exposed in numerous sites and to the Corrodkote and Cass tests showed the sulfur-free semi-bright duplex system was better than the others tested. Slides were shown illustrating the results obtained with the various nickels tested and pointed out markedly the conclusions discussed by Dr. Beckwith.

Following the speaker, regular Branch business was resumed: The minutes of the previous regular and 50th Anniversary Committee meetings were read; Treasurer Mentzer gave the financial report; reports were given by chairmen of the 50th Anniversary Committees; the secretary presented for payment the warrant for the 1959/60 AES per capita tax and explained how the total was determined.

The secretary presented the following change in the Branch Bylaws removing the meeting day, time and place from the Bylaws, which was adopted unanimously: Article III, Section 1, 2 and 3 shall be combined into one section to read: Meetings: The Branch shall hold regular meetings once each month from September through May on a fixed day, time and place approved by the Branch members, unless otherwise provided for and duly publicized by the Executive Group.

I. Wm. Marcovitch
Secretary

PHOENIX
Tour Engineering Labs of ASU

Twenty-six members and guests enjoyed the excellent dinner at the Faculty Dining Room of Arizona State University, Tuesday, Nov. 10.

President **William Griff** opened the business meeting at 8:00 p.m. An application for membership was received.

A letter of congratulations to our branch was read **Ezra Blount** of *Products Finishing.*

Delegates and Alternates for 1960 were appointed. **Delegates: James Weaver.**

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BRIGHT NICKEL PROCESS

LEVELMAX

for excellent brightness, levelling, and ductility at low cost

Now—for the widening use of nickel plating and the new plating problems brought about by the wider variety of shapes and base metals—ASARCO has developed a new process, simple to control and maintain. LEVELMAX will tolerate considerable organic and metallic contamination even with infrequent purification or treatment. Buffing and finishing of the base metal can often be completely eliminated. Hard-to-buff areas can be plated bright. The bright-nickel surface readily accepts chrome. Corrosion resistance is excellent. Maximum productivity is assured by high current densities which are successfully used with the LEVELMAX process. Conventional or air agitation can be used. Analytical procedures are provided for the determination of all constituents. Write for complete working details about the new LEVELMAX BRIGHT NICKEL PROCESS to Federated Metals Division of American Smelting and Refining Company, Electrochemicals Dept., 120 Broadway, New York 5, N. Y. In Canada, Federated Metals Canada, Ltd., Toronto and Montreal.

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ASARCO

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William Griff, **John Mullarkey; Alternates: Sam Lewin, Dean Hill, Paul Wible.**

The Ft. Worth-Dallas Air Space Symposium was mentioned. James Weaver will act as delegate to attend this meeting in December.

Pros and cons of having a Christmas Party were discussed by **Bob Axsom.** Members voted to have a party but not to include a dinner.

After the business meeting, **Dr. Clyde Crowley** introduced **Dr. Merle C. Nutt,** Dean of Metallurgy ASU. Dr. Nutt conducted our group on a tour of the Engineering Laboratories of ASU. After the tour, a regrettably brief talk was given on Metallurgy by Dr. Nutt. We hope we can again have Dr. Nutt so we can devote more time to such an excellent speaker.

PROVIDENCE-ATTLEBORO
Hollerith Discusses Ultrasonic Cleaning

Brett Hollerith of Branson Ultrasonics Corporation, Stamford, Connecticut discussed "The Fundamentals of Ultrasonics and its Applications to Cleaning in the Electroplating Field" at the Nov. 16 meeting of the Providence-Attleboro Branch in the Providence Engineering Building.

Jerry Noonan, chairman, announced that the Christmas Party will be held at the Wayland Manor, on Monday, Dec. 7, 1959.

Edward A. Parker
Secretary

ROCHESTER
Delegates Elected; Illustrated Talk on Chromium by Swain

The Nov. 2 meeting was opened by Past-President **Frank Beuckman** at the Rochester German Club.

The secretary was instructed to cast one vote for the following members to serve as delegates for the year and to attend the National Convention in Los Angeles: Frank Beuckman, **John Cipolla, Anthony Cottrone.**

The forthcoming Christmas party of the Branch to be held on Dec. 19 was discussed at great lengths and steps taken to insure a good turnout.

Following the completion of business matters, the meeting was turned over to **Emil Pottridge** of Schobell Chemical Co. who presented the speaker of the evening, **T. E. Swain** of the technical service department of Allied Chemical Corp. Mr. Swain gave an illustrated talk on "The Production, Uses and Importance of Chromium and Chromium Chemicals."

Following Mr. Swain's very interesting talk, refreshments were served through the courtesy of the Schobell Company.

Barrie M. Gardner
Secretary

ST. JOSEPH VALLEY
Saltonstall Presents Paper; Lockerbie Honored

The Oct. 7 meeting had 55 in attendance.

After a round table of introductions, **Ezra Blount,** editor of *Products Finishing* magazine, was welcomed as our guest and spoke on "The demand for general interest articles rather than scientific papers."

L. Rague, second vice president, announced two new sustaining members, Inland Chemical Co. and South Side Plating Co.

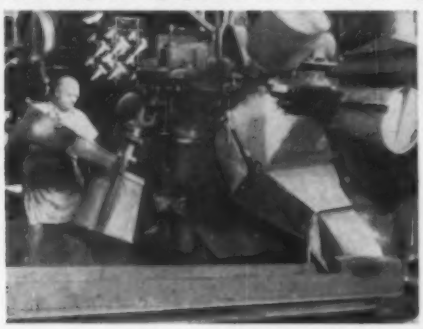
President **Ray Dearth** called on **Gene Roth,** assistant chairman of the Midwest Council, who spoke on the Midwest Regional Council Meeting to be held on Nov. 7 in Rockford, Illinois. Mr. Bill Geisman will be chairman of the meeting. He urged all members to attend. He then spoke of the 1960 Midwest Council Meeting which possibly will be held in South Bend. Also, certificates were passed out to all members who joined AES while he was secretary, a pleasing surprise.

The meeting was turned over to National President **Ralph Wysong** who honored **John Lockerbie** as having been active in AES since its inception. John Lockerbie was 77 Oct. 2 and a birthday card was sent to him. The Oct. 7 meeting was designated as John Lockerbie night. Telegrams of congratulations were read.

National President Wysong thanked the membership for their efforts in backing him and the AES urging attendance at other Branch meetings. Also, he mentioned two new branches to be installed-Phoenix and Denver.

The following nominations of new officers and delegates were read and voted

WHICH CONVERSION COATING TO USE?



Unloading ends of barrel and rack automatic machines

Henry Blessing inspecting hardware products after treatment

STANLEY HARDWARE CHOOSES KENVERT® NO. 17A

At The Stanley Works in New Britain, Connecticut, one of many satisfied customers, Foreman, Henry Blessing, has several reasons for using KENVERT NO. 17A. Included are:

1. Uniform bright work from day to day without staining on difficult parts such as assembled hinges
2. Good corrosion protection
3. Improved product finish with substantial cost reduction
4. Easy solution maintenance

KENVERT 17A, the premium powder, guarantees the best in brightness, corrosion protection, bath life and uniformity of finished product in a single dip treatment. Won't you discover the advantages . . . . . .

NEW! Permanent zinc brightner for barrel or rack work—KENVERT 15BR. Test samples available.

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24 Distributors in major industrial United States cities

KENVERT PRODUCTS SOLVE UNUSUAL METAL FINISHING PROBLEMS

upon: President, **Walter Manson;** first vice president, **Ted Shafer Sr.;** second vice president, **Louis Ragues;** secretary, **Henry Meers,** treasurer, **George Shuman;** librarian, **Jack Petersen;** board of managers, **Clyde Swigert, Richard Aikin, Jos Curtis.**

Installation of officers was made at once by Ezra Blount.

Past President Dearth who was responsible for the bylaws, charter and lectures, thanked the group for the honor of serving as president and was given a standing round of applause for a job well done.

Librarian Jack Petersen gave a brief resume of this year's speaker program. He introduced **Dr. Richard Saltonstall** of Udylite Corporation whose topic was "Role of Agitation". He listed four general types of agitation used in the manufacturing industry as 1) Movement of work rod. (cathode rod), 2) Agitation of solution past surface of work (pumps, propellers, etc.) 3) Agitation with air (solution agitation of 1 type or another), 4) Ultrasonic energy-violent agitation at very high frequency.

Basic reasons for agitation in plating:

1) Good agitation of work or solution, air or ultrasonics accomplishes get away from stratification of concentration of metal ions or temperature.
2) Relationship of film of solution itself, to the work.
   a) No current-boiling (rolling of cleansing solutions) both accelerate and improves extent of obtainable cleaning.
   b) Tumbling work in cleaning barrels.
   c) Racked work by electrocleaning generates a sweeping gas that scrubs surface.
   d) Ultrasonic agitation-impinges cleaner on work surface.

Agitation in Rinsing—basically is a dilution process-agitation is of course of prime importance. Serious problem is removal of alkaline cynides trapped in pores-resulting in spotting out of subsequent plated metals.

Agitation in Electropolishing—too much agitation is not good because process is essentially a polarization process, mild agitation does prevent gas streaking and stratification of solution.

Agitation in Anodizing—prevents stratification of solution and temperature gradient and variations in quality of anodic film.

In purification of plating solutions—intimate contact of absorbents by impurities contained in working solutions is of extreme importance.

Chemical additions to work tanks require stirring for proper dilution of additives.

Affects of agitation in plating solutions containing no additional agents. Reasons and benefits are three fold.

1) Maintain uniform solution concentration and temperature.
2) Give sweeping motion of solution past cathode (no bubbles, no pits, streaks or foreign matter.
3) Increase of limiting anode and cathode current density is a function of speed of solution flow past cathode (Nickel solution) at 750 ft/min-up to 4200 amp/ft–16 sec/mil 10 ft/min–3–400 amp/ft.

Maximum current density at 1000 ft/min flow encountered engineering and mechanical shortcoming rather than electrochem process itself.

Vigorous agitation requires better racking. Agitation in solutions containing addition agents accomplishes:

1) Brings addition agents in better contact with cathode, film and work.
2) Reduces degree of clouds, fogs etc. and improves britness and uniformity of plated deposit.

Dr. Saltonstall showed movies of various degrees of air agitation and means of keeping separated the anode bags and cathode. Air agitation often results in oil slugs being thrown into plating solution. Distribution spiders in tank must be kept level, to avoid localized agitation of solution. Holes in spiders often result in clogging by calcium salts crystallizing, this is easily remedied by passing water thru, intermitent operation of air lines, etc.

After a lively question and answer period Dr. Saltonstall was accorded a standing round of applause for a very interesting paper.

Dr. H. J. Wiesner spoke of the possibility of a plating course if enough interest was shown.

Henry A. Meers

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ST. LOUIS

Plating Problems Discussed by Pavlish

The second fall meeting was held at the York Hotel, Wednesday, Nov. 11 with 14 members and guests arriving in time for dinner. It looked like the holiday for some companies had taken its toll on our attendance but there were 29 members and guests present when the business meeting was called to order by President **William Piel.** One new member was elected. The secretary was instructed to report to headquarters that there probably would be 25 men, six women and ten children attending the Los Angeles convention from St. Louis.

Louis Berra reported the plating school was being attended by 28 students and progressing very nicely.

Andy Julius was called upon to report on the Mid West Regional meeting held at Rockford. He reported there were 255 registered. The Organic Educational Sessions were attended by about 80 with the others attending the Inorganic Sessions. Besides Andy Julius and **Craig McAlister** who served on committees, St. Louis was represented by **Robert Coulson,** William Piel, **Joe Stevens** and **Edward Sertl.**

Gerry Clooney suggested that we reactivate the question box and use a telephone committee to call the members to get them out to our monthly meetings. Craig McAlister was appointed to take charge of the question box and Gerry Clooney accepted the position of chairman of the telephone committee.

Richard Gotsch introduced **Arnold E. Pavlish** of the Cleveland Supply Co. who talked on Problems in Plating. Mr. Pavlish was given a rising vote of thanks for his talk which promoted a very active question and answer session and was considered by many the most informative talk we have heard in a long time.

Ward Kelly
Secretary

SEATTLE-PUGET SOUND

Nelson and Gorton Speak on Cadmium Plating

The October meeting was held October 28, at Andy's Diner, 2963 4th Ave. So.

After a good steak dinner, served to a large group of members, the president called the business meeting to order. Program Chairman **Forster Bradford** of Heath Plating Co. introduced the speakers for the evening. **Philip Nelson** and **Tom Gorton** of Boeing Airplane Co., discussed "Low Embrittlement Cadmium Plating." Such points of interest were covered as technique of racking, certain types of parts, the looks of the "cadmium" plate, dull grey, and rather porous. Also some of the problems encountered by the subcontractors in producing low embrittlement cadmium plate.

A very lively question and answer period followed the talks by Messrs. Nelson and Gorton.

Helen Archibald

SPRINGFIELD

Weary Talks on Lacquer Applications

The Springfield Branch met at Blake's Restaurant, on Monday evening, November 23 for the regular monthly meeting.

Chairman Wayne Sanders of the Activities Committee announced that plans for the Christmas Party had been cancelled but that groundwork was being laid for a family picnic sometime in the early summer. Preliminary planning also is in progress for a turkey shoot in January.

Two new members were welcomed into the Branch.

The balance of the evening was devoted to the Technical Session, with Librarian Louis E. Dupuis presiding. The speaker for the evening was Mr. Frank M. Weary of G. J. Nikolas & Company of Brooklyn. The subject was a general review of "Modern Application of Lacquers." Mr. Weary showed sound color movies on Spray Gun Lacquering and Painting by DeVilbiss which were well received.

Henry L. Heissfeld
Secretary

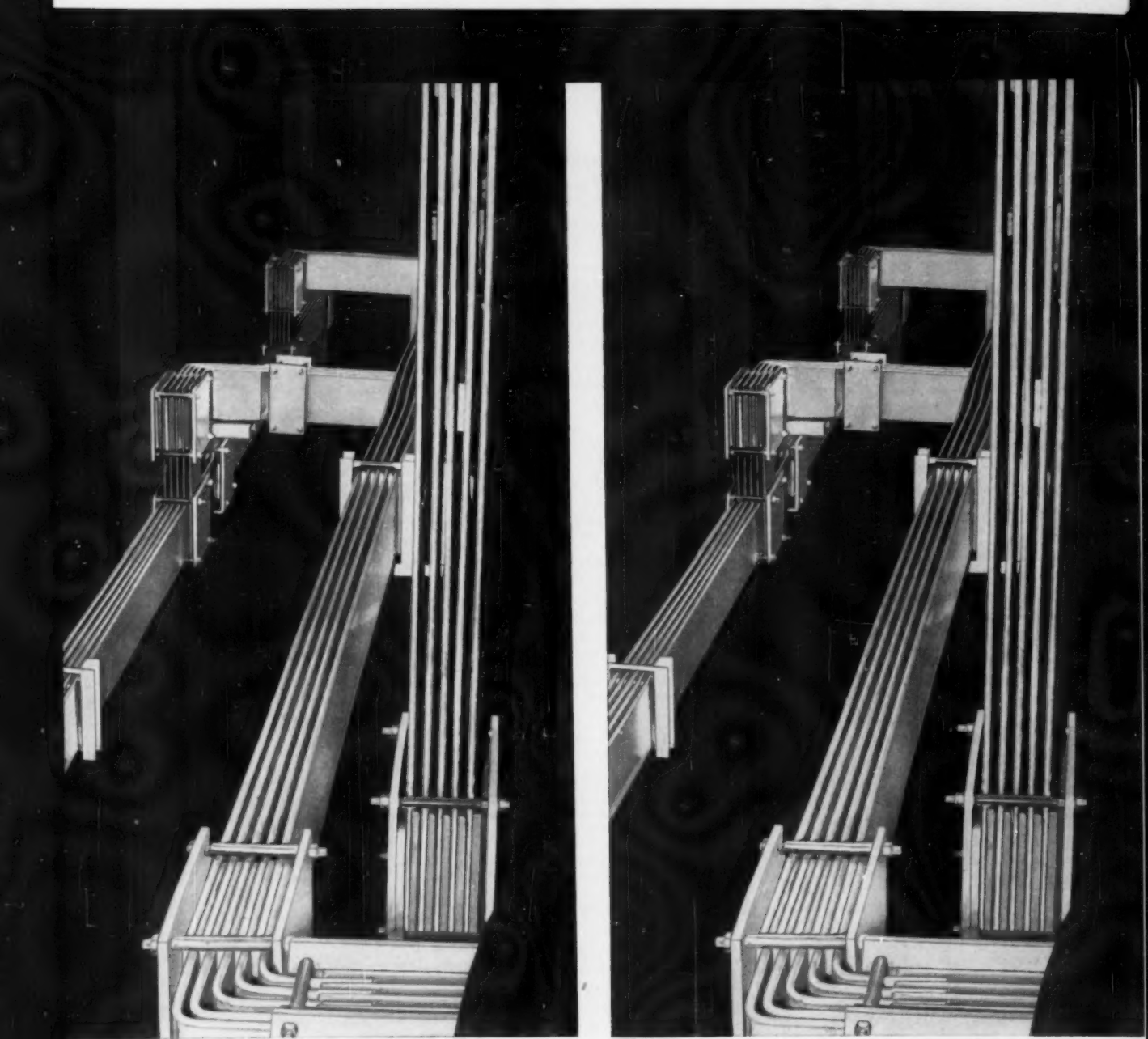
WATERBURY

Newell Presents Paper on Waste Disposal

The Waterbury Branch held its regular meeting at the Hotel Elton on Thursday, Nov. 12. A short business meeting was called to order by President **Frank Tirendi.** The entertainment committee reported that plans are progressing for our annual outing to be held in February. A further report will be presented at the next meeting. **Bill Giesker** reported on the New England Regional Committee which was held in Hartford. He asked for the sentiments of the Waterbury Branch concerning the Regional Committee's plans to do preliminary work for the 1961 Interim Meeting. The Interim Meeting does not fall into the provence of the Regional Committee under the present bylaws.

Perry Sloane introduced the speaker, **I. Laird Newell,** president of The Henry Souther Engineering Co., who gave an excellent paper on the important subject "Waste Disposal". He discussed the State's attitude, requirements and method of operation. He showed slides depicting some systems that his firm was instrumental in designing. The paper was followed by a lively question and answer period.

F. A. Schneiders
Publicity Chairman



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Baltimore-Washington: J. W. Boreton

Blue Ridge: J. A. Harless

Boston: G. N. Chapman, D. G. Earnshaw, R. F. Lavoah, G. P. Rears Jr., P. F. Reddy, R. B. Soper

Bridgeport: F. L. Danaher

British Columbia: L. Talo

Capitol District: L. Bowne

Cincinnati: P. F. Proffitt, R. L. Queenan

Columbus: L. M. Welker Sr.

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Detroit: J. T. Ellis, G. L. Hager, G. H. Knipple, W. J. Lomas, H. R. Wagner

Grand Rapids: D. A. Turskey

Hartford: E. F. Murphy, M. A. Dobkin, T. C. Traceski, C. H. Pernel, A. R. Bubb

Lancaster: D. G. Carroll, H. D. Weeks

Los Angeles: H. R. Morrison, W. M. Gauntt, R. A. Jones, J. Molina, C. Humbert, J. M. Wall, E. Armstrong, F. Wheeler, C. R. Schoneman, G. E. LeBeck, Ed. Johnston

Louisville: L. E. Wilson

Miami: P. F. Gentry

Mississippi Valley: O. L. Nelson, V. M. Nuss

Mohawk Valley: A. Rohrlack

Montreal: H. Ouimet, R. Smith

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Phoenix: L. Sawdy, R. Dezember, G. D. Perrine

Providence-Attleboro: J. W. Hafner, R. Volterra, A. Masse, F. Horlbeck

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Lancaster: J. E. Bemiller, R. F. Vines

Los Angeles: W. B. Ellis, J. LaVoy, E. Hamor, C. E. Tackels Sr., B. Sherwood, D. C. Johnson, F. Taylor

Mohawk Valley: W. H. Wolczyk

St. Louis: R. Goodman, W. Ripplemeier

San Francisco: G. Dufour

Springfield: G. J. Juke

Member-at-Large: R. J. Yackley

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British Columbia: H. A. Mroch to Seattle-Puget Sound

Cincinnati: D. Taylor to Blue Ridge

Los Angeles: G. S. Dufour to San Francisco, F. T. Eddy from Waterbury, E. G. Smith from Philadelphia, P. Harper from Detroit

Philadelphia: R. G. Marshall to Dayton

Pittsburgh: W. Guiltinan from Grand Rapids

Seattle-Puget Sound: H. Mroch from British Columbia

Western Ontario: P. Croly to New York

Member-at-Large: W. H. Kresge to Detroit

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British Columbia: S. R. Lucas

Cincinnati: B. Barrett, C. Konecny, Dr. L. Luft

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Lancaster: E. Wiegand, J. Tamany, C. A. Herbst

Mississippi Valley: T. Preston, J. Mason, C. Buhman

Newark: R. Jacob

Providence-Attleboro: F. P. Avanzo, H. C. Gill

Seattle-Puget Sound: R. H. Smith

San Francisco: A. C. Dall, G. V. Pierce

Springfield: T. M. McLaughlin

Toronto: T. A. Dadson

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Denver: H. Bourgeois

Detroit: R. Richards

Lancaster: F. Weaver, G. LeFevre

Mohawk Valley: R. Bantham, R. G. Blust, D. Day, T. DeJoseph, R. Howard, C. P. Raehm, J. W. Rozycki, E. Stys, B. Tisi

Newark: A. Winter

San Francisco: R. N. Christopher, W. H. Boatsman, G. T. Coleman, B. Harrison, L. R. Invin, R. Leitner, M. Raskin, G. S. Dufour, B. Kelly, H. McQuain, R. Teffs

Springfield: H. Oehler, R. Howe Jr.

Syracuse: C. F. Applegate, T. Werner

Toronto: R. Corras, W. F. Baylay, J. E. Martiquet

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Hamilton: D. Mundy

Philadelphia: Dr. H. S. Lukens

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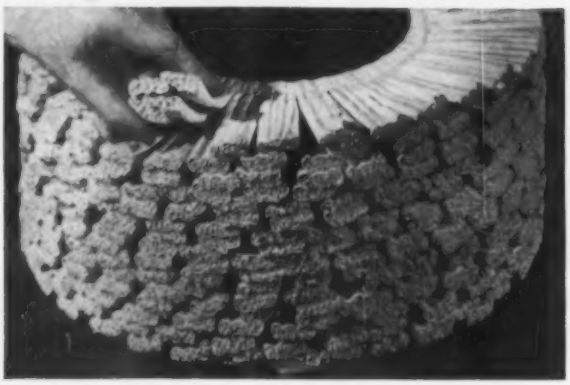

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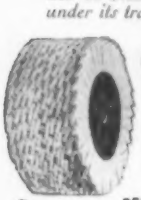

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AMERICAN ELECTROPLATERS' SOCIETY

January 15-16, 1960—Second Annual Dixie Regional Technical Session, Saxony Hotel, Miami Beach, Florida. Sponsored by Miami Branch with Blue Ridge and Southeastern participating.

January 23, 1960—Grand Rapids Branch, Annual Educational Session and Dinner Dance, Pantlind Hotel, Grand Rapids Mich.

January 29, 1960—Editorial Board Meeting, Conrad Hilton Hotel, Chicago, Ill.

January 30, 1960—Chicago Branch, Annual Meeting and Banquet, Conrad Hilton Hotel, Chicago, Ill.

February 6, 1960—New York Branch, Annual Educational Session and Dinner-Dance, Statler-Hilton Hotel, New York, N. Y.

February 18, 1960—Research Committee Meeting, Ben Franklin Hotel, Philadelphia, Pa.

February 19-20, 1960—Seventh Interim Meeting, Philadelphia Host Branch, and Golden Anniversary Educational Meeting and Banquet of Philadelphia Branch, Ben Franklin Hotel, Philadelphia, Pa.

February 19 & 21, 1960—Executive Board Meeting, Ben Franklin Hotel, Philadelphia, Pa.

February 20, 1960—AES Membership Committee Breakfast Meeting, Ben Franklin Hotel, Philadelphia, Pa. (7:30 a.m.)

April 8-9, 1960—Executive Board Meeting, National Headquarters, Newark, N. J.

April 23, 1960—Sixth Tri-State Regional Meeting, Cincinnati Host Branch, Sheraton-Gibson Hotel, Cincinnati, Ohio.

April 23, 1960—Twenty-First Annual New England Regional Meeting, Bridgeport Host Branch, Hotel Statler, Hartford, Conn.

April 29-30, 1960—Sixth Empire State Regional, Southern Tier Host Branch, Mark Twain Hotel, Elmira, N. Y.

July 24-28, 1960—47th AES Annual Convention, Hotel Statler, Los Angeles, Calif.

July 24, 1960—Executive Board Meeting, Statler Hotel, Los Angeles, California.

September 17, 1960—Boston Branch 24th Annual Educational Meeting and Banquet, Hotel Statler, Boston, Mass.

February 3-4, 1961—Third Annual Dixie Regional Technical Session, Hotel Roanoke, Roanoke, Virginia. Blue Ridge Host Branch.

June 18-23, 1961—48th AES Annual Convention, Hotel Statler, Boston, Mass.

FUTURE MEETINGS

June 25-28, **1962—49th AES Annual Convention,** Schroeder Hotel, Milwaukee, Wis. Sponsorship Midwest Regional Council.

June 24-27, **1963—50th AES Annual Convention,** Ambassador Hotel, Atlantic City, N. J. Sponsorship Newark Branch.

June 21-25, **1964—51st AES Annual Convention,** St. Louis, Missouri

July, **1965—52nd AES Annual Convention,** Statler Hotel, New York, N. Y.

INTERSOCIETY

January 12-15, **1960—Society of Plastics Engineers**—16th Annual Technical Conference, Conrad Hilton Hotel, Chicago, Ill.

January 26-27, **1960—Society of Vacuum Coaters** Third Annual Meeting, Hotel Biltmore, New York City.

February 1-5, **1960—American Society for Testing Materials,** Committee Week, Sherman Hotel, Chicago, Ill.

February 1-5, **1960—Instrument Society of America,** Instrument-Automation Conference and Exhibit, Houston Coliseum, Houston, Texas.

February 19, **1960—Joint Evening Meeting,** Board of Trustees, Metal Finishing Suppliers' Association (MFSA) and Executive Board, American Electroplaters' Society, Inc. (AES), Ben Franklin Hotel, Philadelphia, Pa.

March 14-18, **1960—National Association of Corrosion Engineers,** 16th Annual Conference and 1960 Corrosion Show, Dallas, Texas.

May 1-5, **1960—The Electrochemical Society,** Spring Meeting, LaSalle Hotel, Chicago, Ill.

May 9-13, **1960—American Society for Metals,** 2nd Southwestern Metal Exposition and Congress, State Fair Park, Automobile Building, Dallas, Texas

June 26-July 1, **1960—American Society for Testing Materials,** 63rd Annual Meeting (with Apparatus Exhibit), Chalfonte-Haddon Hall, Atlantic City, N. J.

July 22-24, **1960—National Association of Metal Finishers,** 5th Anniversary and Membership Meeting, Hotel Statler, Los Angeles, California.

October 9-13, **1960—The Electrochemical Society,** Fall Meeting, Shamrock Hotel, Houston, Texas.

October 17-21, **1960—American Society for Metals,** 42nd National Metal Exposition and Congress, Trade and Convention Center, Philadelphia, Pa.

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